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A CONSIDERATION OF THE MALIGNANT PROSTATE AND ASSOCIATED OBSTRUCTIVE MANIFESTATIONS*

JOSEPH F. MCCARTHY, M.D., AND SAMUEL E. KRAMER, M.D.

NEW YORK CITY

THAT elusive will-o-the-wisp, Cancer, is my theme; that secluded though none the less potent part of the human anatomy, the Prostate, my designation.

To envision, adequately, malignancy of an especial sector of the body, necessitates primarily a consideration of the etiology, growth characteristics, cellular classification of the disease as an entity, its role as an insidious invader, and finally, the set-up of our defensive mechanism of prevention, eradication, or alleviation.

The sinister role of cancer may well be compared to the tactics of a modern army. Its chief means of attack are by infiltration, rear attacks by metastasis, the discharge of lethal substances, and the blockading of routes of supply and evacuation. To successfully combat this ruthless enemy of mankind, implies its complete annihilation before it has dug itself in.

Inasmuch as the histological aspects of the general subject will, during this intensive Fortnight, be given elaborate consideration and accorded authoritative opinion by others, and because it does not come within either the time allotted to, or the scope of our thesis, this aspect will of necessity be treated somewhat sketchily, and only such high points will be emphasized as appear to have a practical application.

FREQUENCY OF OCCURRENCE

Early statistics stated that carcinoma of the prostate was a rare disease, forming between 0.27 per cent (Gurlt) and .418 per cent (Heimann) of the carcinomas of men. Recently, with more careful examination of apparently simple hypertrophies, and more accurate diagnoses, these impressions have been revised. Dossot of the Necker Hospital reports 680 prostatic tumors between January 1, 1919 and July 15, 1925. In this group, cancer was found in 123 cases or 18 per cent of the total.

Because of the atypical glandular hyperplasia in the chronically hypertrophied and inflamed prostate, the microscopic diagnosis of precancerous and early cancerous areas may represent a higher percentage of malignant incidence, than one would derive from clinical studies of frank carcinoma of the prostate. The distinction must be borne in mind between clinical cancer of the prostate, and the accidental discovery of suspicious atypical glandular growth in the clinically benign hypertrophies. Although the importance of microscopic findings of suspicious precancerous

* From the Department of Urology, New York Post-Graduate Medical School, Columbia University, New York.
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and early cancerous changes in prostatic enlargements should not be minimized, it is, nevertheless, true, that such findings

Carcinoma of Prostate.
Erosion of muscularis of anterior rectal wall — seminal vesicle obliterated — bladder involvement.

Fig. 1.

are more frequent than is the established disease.

ETIOLOGY

It is the ordered opinion of the writers that unfortunately, we find ourselves in the same nebulous, speculative state of knowledge of the causation of this disease as we have been in the past. Theories have been advanced, that long-continued low-grade irritative processes are potentially provocative, or that pre-existing inflammation may have a predisposing influence in the evolution of this condition. If there be the slightest basis for such hypotheses, it would appear excusable to ascertain how such conceptions or misconceptions, as the case may be, can apply to our particular subject.

It has long been accepted practice in the prophylaxis of cancer of the mouth, to advise correction or removal of rough or jagged teeth. The eradication of adventitious skin outgrowths, such as moles, papillomata, fibromata, etc., has also been proposed with the same objective, the prevention of malignancies. The preceding are illustrative of mechanical irritative effect.

Long-continued urinary hyperconcentration has been suggested as a possible cause for bladder neoplasms. It seems reasonable also to assume that inflammation may here function as a point of departure in the evolution of malignancy. Inflammation implies stasis—stasis inflammation.

It is axiomatic that anything which inhibits the normal interflow of secretory or excretory fluids must eventuate in congestion. It is likewise tenable to infer that such a condition, long continued, may well result in the disordered state of cell activity we call cancer. When the inconceivably complex cell life of our bodies is remembered, their supremely fine adjustment, the one to the other, their biochemical activities still beyond our ken, the constant state of sustained or intermittent activity of the organs of which they form the structure, it should not be a source of surprise that the motivating power behind these activities may cause them from time to time, to "jump the rails."

The hereditary aspect of the lesion insofar as concerns prostatic malignancy is still conjectural. Nevertheless, the most serious consideration should be accorded an antecedent family history of cancer.

Since the introduction of the revolutionary method of endoscopic revision for prostatic obstructions, histological examination of excised prostatic tissue has proved that practically all these prostates are congested or waterlogged, and are the site of acute or chronic inflammation. This fact has been generally admitted, but has not been sufficiently stressed. Cultural examination of the expressed secretion in these seemingly quiescent stages not infrequently demonstrates the fact that this organ may be the harbinger of specific bacterial strains. There is too, in all probability, such a condition as prostatic toxemia. The question, therefore, may pointedly be asked: do these low-grade

congestions and inflammations play a role in prostatic enlargement, which latter, as Ewing points out, are the chief predisposing conditions in the causation of cancer in 10 per cent of the cases. The same author also states "that early or suspicious cancerous changes in the prostate are more frequent than is the established disease." The logical inference from this is, that the epithelial hyperplasia seen in prostatitis and hypertrophy may assume the microscopic characteristics of early cancer.

HORMONES

Lower and his associates have succeeded in transplanting the anterior lobe of the hypophysis in one animal, and then have established a cross circulation between this animal and another. This caused the second animal to develop an enlarged prostate gland. They feel that such experimental study demonstrates that a hypersecretion of the anterior lobe of the hypophysis may lead to an enlargement of the prostate gland, and that this possibly may be the mechanism of prostatic hypertrophy.

DIAGNOSIS

The early diagnosis of cancer of the prostate must, in large measure, rest with the internist, the general practitioner, for it is they who are first consulted. Prostatic palpation should be, but all too frequently is not, a routine step in a physical examination. To palpate liver, kidneys and spleen in a man past fifty and neglect such examination of the prostate, is a manifest absurdity. To substitute urotropin or other so-called urinary antiseptics in such an individual, with micturitional frequency, especially nocturia, for the critical examination of the qualified specialist, is a violation of trust. Figuratively speaking, the diagnostician cannot bowl in too many alleys.

Because of the fact that 85 or 90 per cent of prostatic cancers may readily be detected by the examining finger, the diagnosis here is relatively easy. Conversely, the responsibility is great. The classical signs are nodulation, induration, fixation. Instrumentally, suspicion of malignancy may be aroused by an obvious loss of normal elasticity, during the introduction of the endoscope. By abnormal induration, by atypical visual changes at or about the vesical neck, and finally, by the fact that the severity of the symptoms is frequently out of line with the objective findings. Other instrumental methods in early diagnosis will be considered under the heading of Prevention. All the foregoing, quite naturally, are but supplemental to personal, family history, general physical, *x*-ray, findings, etc.

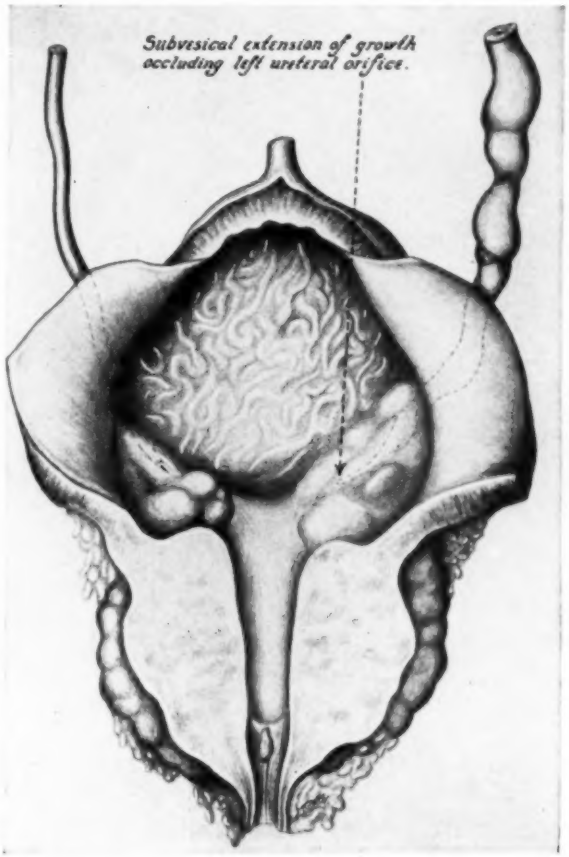

Fig. 2.

PREVENTION

From the preceding partly factual, partly speculative commentary, it becomes obvious that prior and subsequent to the

advent of prostatic hypertrophy, these cases call for something more than the customary digital, instrumental, radio-

Fig. 3.

graphic and colorimetric examinations that is current practice today. It should be remembered that approximately 25 per cent of all male mankind experiences in greater or lesser degree the trials of prostatism, that the preponderating number of prostates removed in whole or in part gives evidence of pre-existing acute or chronic inflammatory disease. It seems a reasonable deduction, therefore, that from the standpoint of prophylaxis as well as in the eradication of infectious foci, in so far as concerns this particular field, the medical profession has not been alive to its obligation.

For the proper conception of this organ, there are several important tasks. The first concerns the stressing of routine palpation of the prostate, and where not contraindicated, the microscopic and cultural study of the expressed secretion; that infections when found should be cleared up. The second concerns the recognition of the fact that early prostatic obstructions are now susceptible of correction by means of endoscopic revision without the necessity of open operation, at least in this stage of the disease. That this method should function efficiently as a control, in the prevention of the vicious cycle of prostatism which has heretofore debilitated so many individuals, before either patient or physician could bring himself to a decision on the much more serious operation of prostatectomy. If, as has been asserted, at least 25 per cent of all men sooner or later come under this category, the economic and sociologic importance of this professional obligation needs no emphasis here. Finally, mindful of the authoritative claims previously mentioned in this paper, that 10 per cent of prostatic hypertrophies degenerate into cancer, it seems but reasonable to deduce that by preventing prostatic hypertrophy as here noted, we may thus lower the incidence of malignancy of this organ.

ERADICATION

By early recognition and removal of low-grade prostatic inflammation we at least are adding something to the credit side of the prostatic ledger. This is now accepted practice in the treatment of endocervicitis any by endoscopic excision of early intraurethral prostatic encroachments, there is the compensatory relief of exaggerated micturitional effort, a lessening of intra-capsular tension, and a probable subsidence of the gland volume. This is advocated as a most desirable step in benign hypertrophies and as a means of occasional early diagnosis of malignancy. Once, however, a diagnosis of frank prostatic malignancy has been established, the chances for cure by whatever method are indeed slim.

Occasionally a patient is seen wherein a suspicious nodule may be noted, when the process is still within the capsule. Such a case may then be treated by the radical perineal prostatectomy of Young, with what has been claimed a fair measure of

success. Or a case may be encountered in which the juxta-urethral portions of the prostate removed by endoscopic revision may reveal an unsuspected malignancy. In such event, radical suprapubic prostatectomy may yield a favorable outcome. These cases are comparatively rare, and from the clinical standpoint, negligible. Once a prostatic cancer has been definitely established, as most of them are when diagnosed, failure of cure by whatever method is almost a foregone conclusion, except possibly and remotely so, by the ultraradical step of combined total cystectomy and prostatectomy, with ureteral reimplantation.

When we stop to consider that in 30 to 34 per cent of prostatic cancer, bone metastasis is already present, and according to Dossot of the Necker Hospital, Paris, in 36 cases studied by him, 34 showed involvement of the ileopelvic glands, and in 33, abdominal glands were invaded; because also of the rich vascular and lymphatic supply of the prostate, its early extension beyond the capsule, its not infrequent invasion of the seminal vesicles and bladder, the futility of complete surgical removal of the vast majority of such prostates is obvious.

RADIUM

It is the fixed conviction of the writers that with our present methods, radium never has effected, and never will effect a cure in frank cancer of the prostate. It is here conceded that radium can destroy a malignant growth. To be used effectively, however, which implies patient welfare also, one must comply with all of the following prerequisites: complete accessibility; implantation with mathematical precision; the avoidance of damage to adjacent organs. To be successful, every cancer cell in a given growth must be destroyed. Inasmuch as cancer of the cervix is susceptible to these requirements, the comparative success of radium here is understandable. It is ridiculous to assume that by the methods advanced to date the prostate is amenable to any such precise irradiation.

We regard the use of the term Arrest as

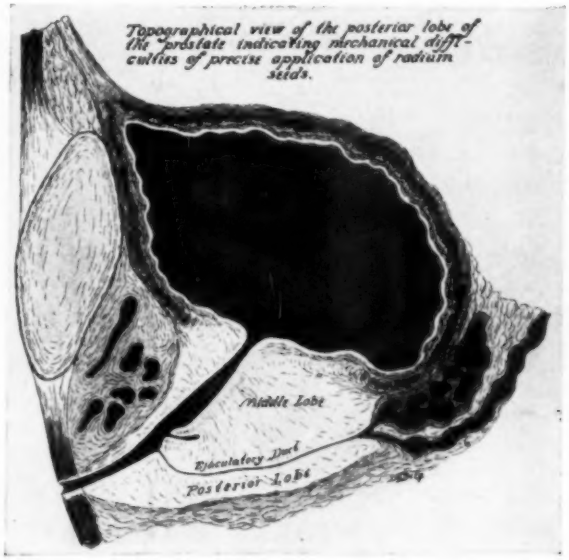
Topographical view of the posterior lobe of the prostate indicating mechanical difficulties of precise application of radium seeds.
Middle Lobe
Ejaculatory Duct
Posterior Lobe

Fig. 4.

applied to radium therapy of cancer, as evasive, equivocal and misleading. Arrest means to stop, and unless every cancer cell is destroyed, such cancer may be retarded,—it is not arrested. A rattlesnake may be slowed down to a walk, but it still has its sting.

While radium seems to act as a destructive agent, *x*-ray appears to exert its effect along the lines of growth retardation and fibrous tissue replacement. As a curative agent in prostatic cancer it, too, is a failure. In the treatment of carcinoma of the prostate with either of these methods as a curative agent, our experience has been unproductive as to result and disquieting alike to patient and observer. Nevertheless, there is a field of usefulness for irradiation even in these relatively inaccessible and indurated tumors. Unfortunately, radium has been broadcasted and press-agented to such extent as to give the public a grievous misconception of its advantages, out of all proportion to its real value. If we are ever to accomplish anything with radium as a curative measure in early carcinoma of the prostate, the most complete surgical exposure of the organ is an

essential prerequisite. This may only be accomplished by the combined perineal and suprapubic routes. Such half-hearted measures as the plunging of radium seeds into the prostate through the unexposed organ or by means of suprapubic exposure alone, must always prove ineffective. It seems to us the future may show, that a cross fire via the urethral, suprapubic and perineal routes, in the thus exposed prostate, offers the one prospect of possible cure by this method, that at the same time protects the juxtaposed structures. In the use of irradiation, however, one should always be mindful of the possible precipitation of metastases by either of these agents.

PALLIATION

It is in this field the most notable progress has been made. Until recently, it has been accepted practice in the case of advanced carcinoma of the prostate, manifesting obstructive symptoms, to advocate permanent cystostomy and such additional steps perhaps, as irradiation, narcotics, anodynes, etc. Today, with the newer methods but recently introduced, supplemented with *x*-ray therapy, we can continue the patient's economic usefulness, restore his bladder function, and in considerable measure, control the inevitable pain up to the terminal stage of the disease. By the method herewith illustrated and reported by us about a year ago, even the densest of prostatic malignant encroachment on the urethral lumen may be removed by a wire loop charged with a cutting current, comparable to the radio current, as though it were so much plastic material. It is thus possible in most instances, without open operation, to tunnelize the prostatic urethra at will, to exercise a complete control of possible subsequent intrusions. The technical details, difficulties and the requirements for success of this method have been elaborated in previous communications. The application of deep *x*-ray therapy for pain alleviation in these cases has been a veritable godsend. In two of our recent cases of rapidly growing prostatic cancer, it has been spectacularly successful in the control of late secondary bleeding. In what type of prostatic cancer this treatment shall be employed, whether it shall precede or follow this corrective operation, is a matter for future determination.

Whatever of controversy there may be as concerns the application of endoscopic revision to other types of prostatic obstruction, there is general accord with the opinion that regardless of its problematical value in life extension, it offers the individual afflicted with this disease a degree of comfort and economic usefulness hitherto unattainable.

The indiscriminate or routine application of deep *x*-ray therapy, however, should be avoided. The method is not innocuous. It perhaps should not be employed, save as a last resort in very aged or debilitated patients. Two of our cases went downhill rapidly following such treatment. Moreover, all cases should be closely scrutinized for physical defect and subjected to preparatory treatment, such as large fluid intake, upbuilding with a high caloric diet, colonic irrigations, etc., prior to its administration.

SUMMARY

This communication considers:

1. The importance of early diagnosis and treatment of that exceedingly common condition, low-grade prostatitis.

2. It stresses the necessity of the same scrutiny of this gland by the diagnostician, as is accorded kidney, liver and spleen.

3. It focusses attention on the fact that with the newer methods at our disposal and the early removal of incipient obstruction, 25 per cent of all men may escape the disabling sequelae of prostatism, that their full economic usefulness may be maintained, that they may thus be spared the spectre of a grave operation at a time when their mental capacity is at its peak and their physical resistance in decline.

[Concluded on p. 274.]

THE CLINICAL COURSE OF

BLADDER NECK OBSTRUCTIONS ATTRIBUTED TO SCLEROSIS OR BAR*

EDWARD L. KEYES, M.D., F.A.C.S.

NEW YORK CITY

A CONSIDERATION of obstruction to the passage of urine from the bladder may well begin with observations concerning certain clinical phenomena which bear upon the problems of bladder neck bars and scleroses.

It has been noted, for example, that bladder stone is all but unknown as a clinical entity in women who, if they did not insert foreign bodies into the bladder, would be able to pass all the stones that reach it except those that are formed and retained upon a silk ligature or upon the hairs of a dermoid cyst that has ruptured into the bladder. But it is a commonplace at almost all ages of life to find stones retained in the male bladder until they grow to sufficient size to warrant operation.

Diverticulum, it may be noted, occurs in the female bladder but is very rarely a clinical problem. The diverticulum usually remains small and uninfected while those of the male bladder become distended and infected and so require operation.

It is not impossible that this difference in retention is due to the presence of the prostate at the bladder neck which sets this region of the male into a more fixed opposition to the outlet of urine than is likely to occur in woman.

The foregoing considerations were suggested by a study of 100 or more cases of so-called bladder neck bar and sclerosis,† during which study it became apparent that it was improper to attribute bladder stone and diverticulum to resistance at the bladder neck, and yet to argue this resistance inflammatory in origin and sclerotic in conclusion. Manifestly the original obstruction must be anatomical. The secondary obstruction arising as a result of infection is inflammatory and ultimately sclerotic.

If specimens obtained by any operative procedure from the bladder neck are examined, there will be found a variety of lesions of which Randall has already given so good an account that one need only enumerate them.

In the mucosa may be found inflammation, erosion, ulceration and cystic or adenomatous enlargement of the glands of the bladder neck (subcervical glands).

The inflammatory lesions may extend into the muscle and the muscle may also show hypertrophy, which hypertrophy is probably due to the efforts of the trigonal muscle to pull open the bladder orifice against the rigidity of sclerosis or of hypertrophy of the underlying posterior commissure of the prostate gland. This muscle hypertrophy may show itself as spasm.

Properly speaking, the term sclerosis of the bladder neck should be reserved for those rather rare cases whose active inflammation has subsided and left behind a mass of rigid scar. Such cases are so rare, however, that all of the inflammatory lesions even mucosal swelling and muscular spasm tend to get themselves grouped improperly under the title of sclerosis and thus to permit of a distinction of the bladder neck obstructions into three types:

1. The (inflammatory or) sclerotic.

† *Southern M. J.*, 1932.

* Read before the Section on Genito-Urinary Surgery, N. Y. Academy of Medicine, February 17, 1932.

2. The prostatic bar (characterized by hypertrophy of the posterior commissure but from which the specimens removed by urethral operation may show little more than hypertrophied muscle).

3. The middle lobe due to hypertrophy of the subcervical glands.

Randall insists that sclerosis of the prostate itself has no clinical interest. But observed cases and specimens well studied show sclerosis, whether of the commissure or of the lateral lobes, as an integral part of the problem. Indeed when a patient past sixty years of age is diagnosed by cystoscope as suffering from bladder neck obstruction, this by no means disproves the presence of somewhat sclerotic lateral lobes projecting into the urethra and requiring attention if the obstruction is to be fully removed.

The problem of the so-called "sclerosis" and "bar" is therefore a clinical one based upon a complex pathology which involves hypertrophy or sclerosis of the various prostatic lobes as well as inflammation of the bladder neck itself.

Sclerosis of the bladder neck is due in many instances to surface infection. Obvious examples are cases derived from gonorrhea or from bladder stone. Others that arise from prostatic infection may be gonorrheal or influenzal.

It is the object of this paper to narrate a few case histories illustrating the clinical history of these obstructions with a special interest in the sclerotic rather than the hypertrophic ones. The case histories selected for the previous paper have not been repeated in this one.

Quite obviously the treatments accorded these patients (of which the Caulk punch (for slight obstructions) and the suprapubic rongeur of Fuller, combined if necessary with lateral lobe prostatectomy, have been the most successful in our hands) do not take into consideration the recent developments in electricity which have made the Stern-Davis-McCarthy urethral operation so successful. This operation would perhaps have been used in many of these cases were they operated upon today. Yet we have employed this technique on too few cases to permit of reporting upon it except to state that the brilliancy of its results is balanced by the lack of tactile resistance to this instrument. With it more damage can be done than with any of the previous urethral operations.

The first case we wish to report has no other than a purely historic interest. It surely was not a case of prostatic bar, it was not even diagnosed as such in 1863 nor yet again in the 1880's. But it illustrates how far we have come, at least in our diagnosis of bladder neck pathology, since the first recorded cases in the office records from which the following documents are taken.

Case 1. "April 24, 1863. W. S., forty-four years old; married, children, merchant; short, stout and healthy, weight 163. Always well until September last when he began to pass water too frequently and this has continued ever since until at present he urinates every one and one-half hours and gets up three or four times at night. The act is slow, stream not rapid at first and somewhat dribbling, afterwards moderately full and forcible. Urine clear and acid. Passed No. 10 E. without pain or obstruction. Prostate seems to me larger than it should be but not tender. Has a hernia. Had gonorrhea seventeen years ago. Has vexation with his wife but has had sexual intercourse regularly until within the last three weeks when his desire has left him. (Vichy water.) Pain in back.

"April 28, 1863. No change. No inconvenience from sound. Continue Vichy. Repeated No. 10. Propose to inject.

"A week later the catheter was passed and found no residual urine. He was treated by the passage of instruments and the administration of alkalies and hot baths and later by injecting the bladder through a catheter with warm water. Then silver nitrate injections which made him worse and to counteract which a blister was ordered to his sacrum. But it is noted that October 3rd, he got a diarrhea and did not put on the blister. Has taken two (Turkish) baths and thinks they do him good. Bladder the same. His pulse is but 46 in a minute. Go to Clark about slow pulsation."

Then follows Alonzo Clark's commentary so much more illuminating to us than to him:

"30 East 21st Street, October 6, 1863.

Dear Doctor: I am obliged to give your patient a transverse heart diameter of 5 inches instead of 4, and if I mistake not there is some obstructive disease of the aortic valves. In other words he appears to me to have some hypertrophy and slight valvular disease. These, however, will not account for the slow pulse. This slow pulse is not constant. On Sunday it was as frequent as 82 in the standing attitude and 66 sitting.

"In the urine I find nothing to explain the impatience of the bladder, but it contains a few of the small hyaline casts, the diagnostic value of which has not been ascertained. I have not examined the prostate. Yours truly, A. Clark."

No one examined the prostate again nor does the capacity of the bladder to empty itself seem to have been tested again but the conjunction of an irregular and obscure vesical disorder with impotence and changes in the aortic valves does not support the diagnosis of "Nevralgie du Col Vesical" which twenty years later Dr. Alexander wrote at the top of Dr. Van Buren's page.

In contrast to the preceding, Case II may serve to illustrate our present more precise pathology and diagnosis.

Case II. 1931. G. A., sixty years of age, has lived for many years on an Alabama farm and weighs 82 pounds; is leather skinned. He gives a history of many attacks of chills and fever and has been treated for syphilis and operated upon for hemorrhoids. He gives a confused and unconvincing history of syphilitic infection.

For fifteen years urination has been slow, frequent, difficult and slightly painful. This did not constitute an inconvenience until within the past four years. Of late it has been much worse and he urinates every two hours by day and every hour by night in small quantities. For the past two years he has had a purulent urethritis and at some time within that period a perineal abscess which burst behind the scrotum and in the right groin. He has also suffered many cramp-like pains in his lower extremities of late. During this time he has had much bladder irrigation and three cystoscopies, after the last of which he had high fever and nearly died. Two weeks ago the bladder neck was stretched, probably with a Kollman dilator, and this made him bleed freely and was followed by fever.

He is weak and lean and though about 5 feet 7 inches in height, weighs but 82 pounds. His skin is an unhealthy brown. His blood pressure 116/84. The reflexes of knees and ankles are very feeble and the pupils react slowly. Catheter draws 75 c.c. of muddy urine after urination and he states that such has been the case for some time. A 25 F. bulb goes readily through the anterior urethra. There are fistulae in the right groin and in the perineum through which no urine comes. The prostate seems fixed by an extensive flat scar which though irregular and concealing the outline of the prostate is not adherent to the lateral pelvic wall and does not suggest carcinoma. Abdominal and bimanual pelvic palpation reveal nothing abnormal. Cystogram shows a defect in the left side of the floor of the bladder such as might be produced by an infiltrating tumor. Cystoscopy under spinal anesthesia reveals cystitis and trabeculation, no diverticulum, tumor or stone. The cystoscope enters the bladder with the greatest difficulty and shows an area of granulations at the upper part of the left side of the bladder neck but no intrusion of prostatic lobes and only a slight bar. The bladder capacity seems to be about 300 c.c. Spinal fluid shows negative Wassermann reaction, negative gold curve, no increase in globulin, 13 lymphocytes. Kahn test negative. Urine has a specific gravity of 1012, is muddy with pus and contains many gram negative bacilli and a trace of albumin. Intravenous P. S. P. 55 per cent; blood nitrogen 40; creatinin 1.8. Smear of urethral pus shows many gram negative bacilli.

The patient had no bad reaction from cystoscopy and accordingly under a spinal anesthesia the bladder was opened supra pubically and a very densely fibrous bladder neck was found but no stone, no diverticulum, no tumor, vesical or prostatic. The bar was cut away by rongeur forceps whereupon no lateral enlargement of the prostate was discovered in the urethra, but a thin sliver of the right prostatic lobe was removed with the rongeur.

The patient was then put in the lithotomy position and that part of the fistula between its two external openings was curetted. Then methylene blue was injected but did not appear through the fistula until this was opened

backward toward the perineum on a probe and the fistula found to open into the bulbous urethra.

Suprapubic and perineal tubes were introduced and though the patient had a violent postoperative temperature reaction and a fever of 104° F. for about five days, his general condition remained no worse than when he had entered the hospital and when the temperature fell he improved rapidly and was relieved of the cramp-like pains in his legs which had been interpreted as possibly due to tabes, in spite of the negative spinal fluid reaction.

The recovery was slow. It took three months and two more reparative operations to get him in condition to return home, weighing 100 pounds, his fistulae healed. The pathologist reported chronic fibrosis, acute suppuration, slight adenomatoid hyperplasia.

This bladder neck was undoubtedly both inflamed and sclerotic.

A singular feature of his case was that on three occasions spinal anesthesia, though effective, so excited his leg pains as to require general anesthesia to still these.*

Case III, though the operation was performed many years ago, and lacking a pathological report, illustrates inflammatory and ultimately sclerotic rigidity of the bladder neck due to bladder stone and for which much dilatation (the details of which have been omitted) did not bring relief. The case also illustrates a satisfactory result of the Chetwood operation but for the incontinence of urine that may complicate a perineal procedure.

Case III. 1892: B. G., forty years old. Urate stone crushed. Acute retention followed operation. Two months later 3 ounces of residual muddy urine. Prostate feels normal. Slight frequency of urination. Bladder irrigation for six months did not clear infection.

1897: Lost 40 pounds. Urine muddy, no sugar. Has probably had fever. Constant pain about the left loin but kidney cannot be felt. Residual urine 2 ounces.

1900: Up once at night, otherwise urination normal. Urine acid, muddy, trace of albumin. Symptoms suggest arthritis of left hip. Search for stone negative. Left kidney cannot be felt.

1902: Has been well until a chill followed by great urinary frequency a month ago. Urinates q. 3 h. by day and twice at night. Thick deposit of pus. Temperature to 100°F. frequently. Urethra 7.5 inches long; residual 1½ ounces.

Two months later the infection had passed, the deposit of pus was much less, residual urine 2½ ounces; frequency same.

1905: Condition same. "Prostate per rectum very moderately enlarged bilaterally. Urethra 8 inches long."

May, 1905: Two stage Chetwood operation. At the first operation "very tight contracted bladder neck which is split slightly with knife so as to allow introduction of tube. There is some bilateral intravesical growth." Bladder neck burned a week later. Epididymitis followed. In November empties bladder, urine cloudy but deposits no pus and has no odor. Urinates every two to four hours.

"Has to wear a towel on account of slight occasional leakage of urine both day and night."

1910: Temporary disability of right side (hemiplegia?) twice within two weeks. Has lost 20 pounds; weight 257. Incontinence continues. Urine hazy, 1.025, great polyuria, 7 per cent sugar.

1911: Weight 172. No sugar (two observations). "Urinates less frequently."

Case IV is interesting because at the time the Chetwood operation was performed the hypertrophied prostate was actually tunnelled much as is done by the modern urethral operations. The patient was gravely sick before operation. The immediate result was extremely satisfactory, yet later the relapse occurred which seems all but inevitable if one is dealing with a true prostatic enlargement and the patient is not cut down a few years later by intercurrent disease.

Case IV. 1902. T. O. B., sixty-seven years old. Acute retention and catheter once a day thereafter for eighteen months. Severe pyelonephritis. Lost 30 pounds and gained half of it back. Prostate bilaterally enlarged, the finger can just be swept above it. Urethra 8¼ inches. Residual 2.5 ounces; capacity 5 ounces. Chetwood operation, "general moderate prostatic enlargement with distinct bar. As the right

*In December, 1932 the report by letter is: weight 110 lb., general condition excellent, urine not muddy, urination easy and painless, every 3 hours. Slight leak from fistula (perineal?).

lobe is a little the larger, burn is made 2.5 cm. long at its base. A second burn partially detaches a piece of the bar which is then removed with the finger, a piece of tissue the size of a lead pencil and 2 cm. long being taken away." Convalescence uneventful but much thick pus discharged, apparently from the kidney, through the perineal tube.

In four months thereafter he gained 15 pounds and reports by letter, "No pain of any kind—much better than I had hoped."

1904: Weighs 200 pounds. Has had an attack of chills and fever attributed to his kidney.

1907: Prostatectomy elsewhere, presumably suprapubic, and five years thereafter (1912) was having relapsing bladder stone.

Case v is the exceptional one that though not fully relieved by palliative operation did not get into serious trouble for many years.

Case v. 1905: C. A., fifty-five years old, for some ten years has arisen at night to urinate and has had dysuria and occasional attacks of frequent and painful urination. Beginning with a diarrhea six months ago the bladder grew progressively more irritable until urination became every hour by day and four to eight times by night.

The patient is lean and vigorous. Urine free from pus, specific gravity 1.016, trace of albumin. Prostate is broad and flat but does not project into the rectum. Residual 500 c.c. Catheter three times a day and a week later Chetwood operation. "Tight stricture at neck, prostate long and a little thick but nothing worth removing." Thereafter he was seen at least once a year for the next four years. He gained 40 pounds. The urine was bacterial, the retention varied from 100 to 250 c.c. He passed the catheter at irregular intervals. He did not have to arise at night.

This same quasi-unsatisfactory condition continued when he was seen in 1914, 1915, 1916, and 1918. In 1921 he had begun to get up once or twice at night. Residual 200 c.c. Cystoscope showed no intravesical prostatic projection, a small shallow diverticulum back of the right ureter. A Young punch operation was performed and symptoms were considerably ameliorated.

In 1923 he stated he was using the catheter three or four times a year, the urine was cloudy with pus and showed sugar at times, prostate still felt almost normal by rectum and his condition was much the same as it had been since the Chetwood operation.

It is interesting to note that such a patient who has been through a desperate disease will think himself well even though he is in the preliminary stage of a recurrence of retention. This is illustrated by Case vi.

Case vi. 1927: M. J., forty-nine years old, had suffered increasing frequency of urination which began with what was diagnosed as an influenza in 1923. In March, 1927, after a year in bed, he consulted a distinguished urologist who performed a suprapubic cystotomy and probably removed some prostatic tissue. The patient left the hospital wearing a suprapubic tube and still suffering from a great deal of discomfort about the bladder. His surgeon had informed him that he could expect no further relief. When I first saw him nine months after this operation, he was still confined to his bed, nervously utterly demoralized though adequately strong physically. The bladder was full of phosphatic grit. The prostate felt scarred. The bladder capacity was negligible. It was found impracticable to clean up the bladder by any form of irrigation, so the suprapubic fistula was resected and with the rongeur forceps the sclerotic bladder neck was cut away. The psychic effect of the operation was excellent. He was out of bed within two weeks and willing to go home before the slow-healing fistula had completely closed.

Two years later, November, 1929, he was seen again for the first time. He had gained 32 pounds, the fistula remained closed but he was unable to return to work and was passing his urine every hour or so day and night. What brought him back to me was a perineal abscess and the loss of 20 pounds in weight and all his courage. But his general condition was still good. The residual urine was between 25 and 50 c.c. and a cystogram showed dilatation of both ureters and kidney pelves. An extensive mass of scar and fistula and abscess was thoroughly drained in the pelvis and right buttock and a Caulk cautery punch performed. Thereafter he emptied the bladder. He once again promptly left town and was not heard from for eighteen months. He writes in April, 1931: "General health perfect. Have regained 40 pounds since operation. Urinate every hour or two by night, 4 to 6 ounces at a time and

from one to one and a half hours by day." Curiously enough he begins the letter with, "Nothing in this world could please me more than your inquiries regarding my health—general health 100% plus."

Case VII illustrates the time of election for operation. Perhaps our future greater familiarity with these cases will encourage more precocious operations. But in the past our clinical diagnoses have been so inaccurate that it has been impracticable to insist on too early operation for fear of operating upon a patient who might get on for many years without.

Case VII. 1925: H. K., sixty years old, complained of urinating every two hours by day and twice at night with a slowness in starting the stream. Urine was uninfected, prostate soft and boggy but not enlarged as felt by rectum, and the cystoscope showed only a small bar with a residual urine of 100 c.c. He preferred to try palliative treatment so he was returned to his physician who employed sounds, prostatic massage and urethral irrigations.

1927: He returned with hazy urine and a complaint that sounds irritated him. The bar looked the same. There were no trabeculations. The kidney function remained good.

1929: He has had several attacks of almost retention but the residual urine remained at about 100 c.c. as a rule. Cystoscope showed the same bar which had not grown. The trigone was plainly visible but the bladder for the first time showed many trabeculae and the N. P. N. was 53, the creatinin 2 mg. per 100 c.c., while the 'phthalein excretion had fallen to 16 per cent in the first half hour and 27 per cent in the second after intravenous injection. The vasa were ligated and a Caulk cautery punch performed. Within a week he was more comfortable than he had been in a long while, holding his urine three hours day and night. The urine soon became entirely normal and six months after operation he was holding his urine all night and passing 250 c.c. at a time by day but he had a sense of recurrence of obstruction in the urinary stream. A No. 27 F. sound was passed twice upon him and this sense of impediment relieved.

Eighteen months thereafter, in March, 1931, he reported himself entirely well with no urinary disturbance. He was not seen at this time.

Case VIII with its combination of prostatic enlargement, bladder neck rigidity and postoperative nervous demoralization illustrates the case that we have elected for suprapubic relief by the rongeur and is an example of homesickness familiar to us all.

Case VIII. L. H. Q., sixty-eight years old, was well until August, 1929, when he developed a severe tonsillitis and was sick for three months thereafter with various forms of nose and throat infection and a good deal of fever. Within one week from the beginning of this infection chills and fever were followed by frequent and burning urination and suprapubic ache. This was treated by prostatic massage which on one occasion resulted in acute complete retention requiring a catheter for its relief and since which time urination had been three times by night and every two hours by day with a slow and feeble stream.

January, 1930, the patient was extremely apprehensive and 10 pounds off weight (to 165). The urine was muddy with pus and contained many gram negative bacilli. Cardiac and renal functions were normal. The prostate as felt by rectum was symmetrically enlarged to a slight degree. He retained 40 c.c. of urine but when 100 c.c. of potassium permanganate solution was introduced into the bladder he could not pass it. *X*-ray showed prostatic calculi. Cystogram showed cystitis.

On January 17, after ten days of preliminary suprapubic drainage, "tube removed from abdominal wound and the incision in the bladder wall stretched to admit two fingers. With two fingers in the rectum for counter pressure it was then found that the bladder neck was rigid, but the prostate only slightly enlarged. With the rongeur forceps a deep bite was taken in the bladder neck after which it was found that the small right lobe could be enucleated from within the urethra. This was done but the left lobe in which the stones lay was absolutely sclerotic. It was scored with scissors and the bladder neck over it bitten away with the forceps. A few stones were thus dislodged. At the end of the operation the bladder neck which has been very tight was widely open."

The pathologist reported: "Adenomatoid hyperplasia with numerous corpora amylacea and sclerosis of the interstitial tissues with round cell infiltration. Great thickening of the submucosa with ulceration. Bladder neck

hypertrophied. The fibrosis extends from submucosa into muscle with round cells."

The convalescence was very stormy because of several emboli to the right lung and a decubitus ulcer. He was in the hospital for six weeks until the fistula was healed. He was frightened, depressed and would not eat and it was with the greatest apprehension that he was permitted to leave for his home in a distant city, weighing 35 pounds less than when he had entered the hospital and utterly demoralized. But he ate a large meal on the train and from then on felt cheerful and well.

A year after operation he reports general health perfect, weight 173 pounds. Drinks two or three quarts of spring water a day and is up once or twice at night.

Case IX is an illustration of the way in which a tight bladder neck may inconvenience a young man for many years before occasioning enough retention to force him to consult a surgeon.

Case IX. May, 1927: M. M., forty-two years of age, a police officer of vigorous constitution who has passed all physical examinations satisfactorily though his urination has always been so difficult that he does not remember ever being able to empty his bladder while standing. The act of urination was always accompanied by a burning sensation and very slow and strained but not frequent

Gonorrhea in 1901 and in 1922 had not made conditions any worse. Eight months before consulting me a chronic constipation and indigestion troubled him so much that he consulted a physician for this and, after a variety of unavailing treatments, it was found in December, 1926 that he had about 500 c.c. of residual urine but no diverticulum, stone, growth or prostatic enlargement. The cystogram had shown only a large bladder, no dilatation of the ureters. *X*-ray showed no stone. Blood urea 75 gm., creatinin 1.3 gm., P. S. P. excretion 69 per cent in one hour after intravenous injection. Spinal fluid Wassermann reaction negative; no gold curve, no lymphocytes. Blood pressure 140/76. Urine acid, 1.014, trace of albumin, many pus cells.

Urethroscope showed a great lengthening of the posterior urethra and a bladder neck so tight that the urethroscope did not go through it. Cystoscope showed bar.

Suprapubic cystotomy showed a bladder neck so tight and so rigid that the end of the Cameron light could not be forced into the prostatic urethra. The rongeur blade could be introduced only after counter pressure by a finger in the rectum. Six bites were required to get rid of all the dense fibrotic tissue which extended from the bar into the left lobe. No lateral lobes were found. The wound bled quite freely; controlled by a Pilcher bag. Convalescence was uneventful though he carried a pinhole fistula for about six weeks. With this healed the indigestion was relieved, the residual urine had disappeared though the urine was still hazy with pus.

Since then he has not been seen but when last heard from in November, 1930, he still considered him self entirely well.

Case X is one of significant bladder tumor, insignificant diverticulum and postprostatectomy sclerosis, a thoroughly complicated case.

Case X. February, 1930, M. E., fifty-nine years old, had massive hematuria a month ago since which four cystoscopic fulgurations of bladder tumor elsewhere had netted him a loss of 25 pounds in weight and caused him to urinate every hour day and night with a good deal of pain. He arrived at the office lean but with good renal and cardiac function, the prostate slightly and symmetrically enlarged as felt by rectum, residual urine 200 c.c., purulent and having that peculiar odor of putrid blood associated with an infected tumor. Cystogram showed very slight flattening of the base of the bladder in the prostatic region, a tumor on the right side of the bladder and a small diverticulum to the left side. Cystoscope showed the slight bilateral prostatic intrusion and a rather flattish mass of papillary tumor entirely hidden by slough and encrusted phosphates. He was taken to the hospital for a week of bladder irrigation with acriflavine to clear up the infection about the tumor.

On February 18, after a preliminary vas ligation and prevesical section, the bladder was opened, a Grade 1 papillary tumor with base about 2 cm. long was freed by the cautery knife, and eight 1 mc. gold radons introduced into this base. A gauze pad was then placed in the bladder to prevent dissemination of tumor cells and the two lateral lobes of the prostate enucleated in the usual manner. They were

quite adherent, each about the size of the last joint of the thumb.

On March 21, as the suprapubic wound remained open and it seemed impossible to introduce an instrument into the bladder through the urethra, the suprapubic fistula was dilated to admit the index finger and with this the opening of the urethra could only be identified after a sound had been pushed up against it. Further pressure brought the sound through into the bladder and then with the Caulk cautery punch, two large pieces were burned away.

In May the fistula was still open so this was excised and a low growing papillary tumor found at the site in which the radium had been implanted. A specimen was again taken from this (which was reported Grade 1) and fourteen more 1 mc. gold radons implanted. The orifice of the bladder neck was still edematous but wide open. As the diverticulum on the left side of the bladder went through all of the muscular coats and was large enough to admit the end of the little finger, this was turned inside-out and excised within the bladder, the muscle wall closed behind it and a drain left to this point, while the bladder was sutured without drainage and an indwelling catheter left in the urethra. The bladder wound leaked but little. Recovery was prompt.

In March, 1931, the patient was comfortable, the urine still contained some pus cells and cystoscopy showed a small ulcer at the site of radium implantation. There was no residual urine.

In November, 1931, cystoscopy showed no tumor, no ulcer, no retention, no prostatic intrusion, no diverticulum.

Case XI is an illustration of how an encrusted ulcer complicating operation may continue the patient's symptoms.

Case XI. August, 1929. J. D., sixty-three years old: acute retention of urine followed by suprapubic prostatectomy in two operations by a urologist who does not believe in preliminary vasotomy. Both epididymes suppurated and were incised following operation. Thereafter he passed his urine every hour at night, every fifteen minutes by day with much pain and occasional bleeding, neither of which had been present at the time of prostatectomy. In March, 1930, an ulcer was burned through the cystoscope but this did not help.

In July, 1930, he consulted me giving the foregoing history and stating that he had not worked since operation and had lost 20 pounds in weight, to 148 pounds. He was lean and nervous. The urine contained much pus and blood. The prostate felt scarred. Cystoscopy showed an ulcer on a tight bladder neck plus cystitis and trabeculation. Residual urine was negligible (less than 20 c.c.). Renal and cardiac functions were normal.

Local treatment was tried in vain and in August, 1930, a Caulk cautery punch was attempted but the instrument would not work so a Young punch was used. The instrument was tightly grasped at the bladder neck and with it three unusually large pieces of dense tissue were obtained. The result was nil. The patient lived out of town and it was not until January, 1931 that he returned to the hospital where under caudal anesthesia the ulcer of the bladder neck was again seen with the cystoscope and cauterized with the high frequency current. This again did no good whatever; so two weeks later, February 3, 1931, caudal anesthesia was again given and through the urethroscope the ulcer which was now quite large, extending from "two to about eight o'clock around the bladder neck and over the trigone," was freely mopped with swabs soaked in 10 per cent acriflavine and decompression applied. After a week decompression was discontinued and the patient discharged from the hospital, taking caprokol and considerably improved. The 10 per cent acriflavine application was repeated March 3 and March 11 in the office. At the last treatment a spot of exuberant granulations was also touched with liquor hydrargyri nitratis. After this the symptoms were relieved. Patient urinated only once at night and when last seen, April 8, 1931, though there still was a light cloud of pus in the urine the patient was entirely comfortable and holding his water normally.

The last case to be cited is perhaps the most interesting of the group because of its long duration and the combination of dilatation and operation which was required to keep the sclerotic bladder neck open.

Case XII. L. S., twenty-one years old, was first seen in 1906, four and one-half years after his bladder had been ruptured (without fracture of the pelvis) by a crushing injury between a freight car and a brick wall. Immediate supra-

pubic drainage had taken care of the extraperitoneal effusion due to the rupture which was in the region of the bladder neck. For the first two years acute retention occurred once every few weeks requiring relief by catheter and a No. 30 F. sound was frequently passed in order to keep the bladder neck open. A year of remission in symptoms and treatments was then followed by a brief attack of acute cystitis and six months later by an acute spondylitis treated by plaster jacket for four weeks in an orthopedic hospital. After another interval of six months there was a second attack of acute cystitis which was followed by constant imperative urination and occasional partial retention.

Before the accident the gross weight varied from 145 to 155 pounds. At the time of consultation it was 128 pounds. The abdomen was scarred, the urine muddy with pus and having the characteristic bacillus coli odor. The kidneys could not be palpated, the prostate was scarred and edematous. He was extremely timorous and during three months rarely consulted me. At no time was it possible to introduce an instrument through the bladder neck.

Then in February, 1907, he entered hospital with a bladder palpably distended above the pubes. After another vain effort at entering the posterior urethra the suprapubic scar ruptured, discharging a fountain of urine. After this, with a finger in the suprapubic wound and a sound in the urethra, the thin bladder neck separating the two was readily scratched through but even then only the tip of a No. 26 F. sound would pass through the bladder neck.

Perineal section was therefore performed with the expectation of doing a Chetwood operation but the dynamo did not work and sharp bleeding from the scar about the bladder neck discouraged further advance at this time. The bladder was drained suprapubically and a month later he submitted to general anesthesia for the first time (the perineal section had been done under local anesthesia). The bladder neck was widely incised and the perineal tube inserted for two weeks and after that an indwelling urethral catheter for a month, at the end of which time denudation of the scar about the suprapubic fistula and suture of this under local anesthesia succeeded in closing it. Thereafter the residual urine varied from 300 to 500 c.c. with occasional acute complete retentions and no steel sound could be introduced into the bladder. But in August, the Kollman dilator was introduced and dilated to No. 35 F. without exciting marked bleeding. Under this dilatation in the next few months the residual urine varied from 50 to 700 c.c. and twice he had acute complete retention.

Because of his apprehension dilatation of the bladder neck proceeded very slowly and by January, 1908, the bladder neck was being dilated every ten days to No.40–43 F., subsequent to which he had no acute retentions though the residual urine still varied from 50 to 300 c.c. and on one occasion 1500 c.c.

He continued his dilatation faithfully and himself washed the bladder every few days with potassium permanganate solution until 1911 when he weighed 153 pounds and married. A year later the first of his two children was born and he had a brief acute retention due to a stoppage in the prostatic urethra through which no instrument could be forced and which led to perivesical suppuration.

In February, 1912, the bladder was accordingly opened again through the abdomen under spinal anesthesia. The bladder neck was found rigid but large enough to admit the tip of the finger and the obstruction at the distal portion of the prostatic urethra. The abscess was drained, the sound forced through the stricture and dilatation later resumed. He again neglected himself and in May again had acute retention. Kollman dilatation was resumed and he frequently used a catheter for varying retention.

During all this period he had been utterly poor and when well was acting as ticket chopper in a draughty, damp, sunless approach to the Brooklyn Bridge. He lost weight down to 115 pounds in October, 1913, had a pulmonary hemorrhage and tubercle bacilli were found in the sputum.

At the clinic he was told to drink as much milk and eat as many eggs as he could. His digestion was excellent and he soon learned to consume three dozen eggs and eight quarts of milk a day. In seven weeks he gained fifty pounds and finally in May, 1915 the suprapubic fistula permanently closed though leaving an incisional hernia which required a truss. He persisted in his dilatation to No. 45 F. four to six times a year and in 1920 weighed 214 pounds.

In April, 1928, he had accumulated a considerable capital and decided to have a con-

firmatory opinion. He therefore went elsewhere for his first cystoscopy which was performed while two men held him on the table. Thereafter the bladder neck bled profusely and after urinating every "ten minutes" for four days he returned penitent and was put in the hospital under bladder decompression for five days, at the end of which time most of the bleeding and frequency of urination was controlled but there was an occasional bleeding from the bladder neck for eight months. The tendency to retention of urine reasserted itself. He used the catheter and wash frequently and dilatation was gradually carried up again, the usual residuum being held down to 25–50 c.c.

In 1929, he weighed 240 pounds and though the tendency of the bladder neck to contract was well controlled, his heart began to fail, myocarditis was diagnosed and he proceeded to reduce his weight and restrict his activity.

In May, 1929, the scar about the prostate and some irregularity in cystogram suggested a possible prostatic carcinoma. He had also resumed his occasional bleeding so under caudal anesthesia and with the small cystoscope the bladder was inspected and the prostate palpated. No tumor was discovered nor any prostatic enlargement or bar.

Since 1931, he has been confined to his home by his cardiac inefficiency and has controlled the bladder discomfort by potassium permanganate irrigations.

SUMMARY

1. The presence of the prostate doubtless suffices to make the bladder neck of the male more resistent than that of the female, thus accounting for the rarity of clinical manifestations of stone and diverticulum among women.

2. There are three types of obstruction at the bladder neck:

   a. The inflammatory or sclerotic,
   b. The bar (muscle hypertrophy over posterior commissure hypertrophy),
   c. Middle lobe (subcervical hypertrophy).

3. Any of these may be associated with the others and with lateral lobe hypertrophy.

4. The cases cited are:

   I. Historical.
   II. Bladder neck sclerosis complicated by prostatic sclerosis and periurethral abscess. Debility. Diagnosis from tabes. Repeated operation.
   III. Post-litholapaxy bladder neck sclerosis and bilateral prostatic hypertrophy. Chetwood operation. Partial incontinence. Followed five years.
   IV. Prostatic enlargement. Chetwood operation. Prostatectomy five years later. Illustrating late relapse after urethral operation.
   V. Prostatic enlargement. Chetwood operation. Partial relief for eighteen years.
   VI. Prostatic sclerosis (post-prostatectomy?). Repeated operation. Partial relief.
   VII. Bar. The time of election for operation. Caulk punch.
   VIII. General prostatic hypertrophy. Concretions. Infection due to tonsillitis. Retention due to prostatic massage. Operation. Neurasthenia.
   IX. Bladder neck obstruction causing mild obstruction many years. The patient does not remember that he was ever able to urinate while standing. Marked sclerosis of bladder neck relieved by rongeur (three and one-half years).
   X. The complex problem. Tumor and prostatic enlargement. Radium (twice), prostatectomy, post-prostatectomy sclerosis, Caulk punch.
   XI. Post-prostatectomy sclerosis relieved by Caulk punch. Ulcer and symptoms persist. Healed by chemical cauterization (liq. hydrarg. nitrat.).
   XII. Traumatic bladder neck sclerosis. Repeated operation, dilatation. Followed thirty years.

DISCUSSION

Dr. Edwin Beer: The subject which Dr. Keyes presented in a very interesting way, sclerosis of the bladder neck, is one of the most important subjects that we are called upon to investigate, diagnose, and treat. It is strange that though the French school has for years recognized prostatism without prostatic enlargement, they have failed to recognize the pathology as we see it. During the last twenty or thirty years, America is realizing that these obstructions are usually sclerotic in character, whether associated with adenoma of the prostate or not. On the other hand, the French school has been discussing hypertrophy of the sphincter, attributing these pictures of prostatism without prostatic enlargement to hypertrophy of the sphincter of the bladder, and are recommending excision thereof as a cure. Until Young emphasized the importance of this condition, and showed that it was amenable to a punch procedure, I think in general the urologists had failed to recognize the frequency of sclerotic necks. They of course encountered sclerosed necks in the course of operations for prostatic adenoma, but they did not realize that independent of this condition, sclerosed necks were quite a common ocurrence. In our experience, up to the time of Young's publication, the few cases that we recognized were all treated suprapubically by cystostomy and wedge-excision with or without suture of the mucous membrane on either side of the wedge to the mucous membrane of the prostatic urethra. Some of the cases did beautifully; the frequency was lessened, and the stream was perfect. In some few cases reported, and in those cases in which re-operation for recontracture was done, it was evident that not only had the contracture reformed, but there was a distal contracture, due to the chronic prostatitis, and in that type of case, where you have a combination of sclerosis of the neck and a sclerosis in the prostatic urethra, it is well nigh impossible except by a very radical procedure, such as Crabtree recommended (which I may say I do not think is justified), to obtain a satisfactory result. Whether we will get satisfactory end-results with endo-urethral methods with the improved cutting currents remains to be seen. With the little experience I have had, I feel that a total prostatectomy, such as Crabtree recommended, may rarely, if ever, be recommended.

In our experience, this condition occurs at all ages in males, and I am limiting myself to males, though I think probably the same condition occurs in females, but it is much more difficult to diagnose. It occurs in children, and I have seen many dozen cases in children, boys and rarely girls, of sclerosis of the bladder neck with residual urine and usually secondary enlargement of the ureters. I have some *x*-ray pictures (intravenous urograms) of a patient recently operated upon. Most of you have seen similar pictures in children. These four will illustrate the condition in children. This is in a seven or eight year old child, with 10 ounces of residual urine, back pressure involving both ureters and both pelves with marked obstruction and infection of the upper urinary tract. This particular patient was operated on by me by the suprapubic approach and a wide excision of the contracted neck performed. As a result the bladder empties completely, whereas before the operation the bladder was always found at the level of the navel. The urine is still, however, purulent. As so often happens in these children, the general health has improved remarkably, so that the child gains a pound every two or three days. Others have not used the suprapubic approach in these cases, and they prefer the perineal route, some using the punch, and others, such as Hinman, have used some modality of the high frequency current. These latter methods I have not used. In my own cases, in some of the very young, I have stretched with bougies, and used potassium iodide, which has an effect on sclerosed necks, and have followed such cases for sixteen years with perfectly satisfactory results. They are now grown-up men and have no residual urine. All these cases seem to be based on a disharmony between the detrusor and sphincter muscles (neurogenic?).

The next group of cases occurs before the age of prostatic adenoma formation. These cases are usually easily diagnosed by the residual urine and by the cystourethroscopic picture. I may say that this is very typical. I think that we frequently make mistakes in interpreting the exact physical conditions cystourethroscopically at the neck of the bladder. In general one may say, as one passes the cystoscope in and out of the bladder, and gets up to the verumontanum, one usually finds in the supraverumontanal urethra an excavation; the neck of the bladder sticks up and is

well raised with one to three valve-like frenula on the floor between the veru and the prominent sphincter lip. This picture is typical of neck contractures. As I said, before Young suggested the possibility of using the punch operation, which was subsequently elaborated by Luys, Caulk and especially by Collings, the operation was done by us from above. Since Young's publication, the operations are done almost entirely through the urethra. The first blade urethral electrodes were made in Berlin by Loewenstein. They are knives for use with a bipolar current, and are used just as Collings subsequently used his electrodes for cutting the neck of the bladder. Perhaps eleven years ago I presented a case of contracture of the bladder treated with the older modality of the bipolar current then in use, and twenty-one days after I cut through the neck of the bladder, the patient had a very violent hemorrhage which demanded suprapubic cystostomy and packing. With such electrodes and such a coagulating current, bleeding may be excessive when the slough separates. With the new Peerless generator which we started using in 1924 and the Bovee set acquired in 1927–1928, the cutting current following Collings' suggestion was introduced, and a different type of electrode was used. In 1927 you may remember that my original blade electrodes made in Germany were modified by Rosenburg of Mannheim for this very purpose. It was backed up with a well-insulated piece of bone so that without any trouble at all one could push the cutting blade into the neck. No short circuit can take place as you press the electrode into the neck of the bladder with the Albarran elevator. Subsequently, with the development of these better high frequency currents, the electrode was further modified by me so that the current was brought to a point, and these flexible electrodes which we are using at present have displaced all other electrodes that were used. These flexible electrodes are regularly employed through an ordinary Brown-Buerger operating cystoscope, and can do all necessary work at the neck of the bladder with the cutting current.

The neck is cut with these instruments at five, six and seven o'clock. In five minutes with the Peerless apparatus, the Bovee or the Davis-Bovee high frequency apparatus, one can cut through the neck of the bladder any required depth under vision and get complete relief. In men between twenty and forty, this type of treatment is the simplest we can employ. The sclerosed tissue is cut, and an indwelling catheter is placed in the bladder for three days, and after removal of the catheter, the end result is ideal with rarely any bleeding. Residual urines which have been maximal have been completely relieved, and the patient empties the bladder completely. In older cases, patients over forty, where you see prostatic adenoma associated with contracture of the neck, the question comes up what type of treatment should be carried out. Personally I am in doubt whether they should be operated on urethrally or suprapubically at first. I think it is advisable to treat these transurethrally at the start. This is always done under caudal anesthesia. If you can get rid of the residual urine, I think this simple procedure is to be preferred to any major procedure. A great many of these cases respond quickly to this type of cutting with satisfactory results. There is another type of case, and that is the case of contracture of the bladder neck following suprapubic or perineal prostatectomy. During recent months, I examined a patient who had a prostatectomy done in some other institution and who came to us with 30 ounces of residual urine. He had a contracture of the neck of the bladder, and with this type of flexible cutting electrode we cut through at five, six and seven o'clock, and the patient turned up ten months later with ability to evacuate his bladder completely.

In all these attempts at treating obstructions at the neck of the bladder, whether they be only sclerosis or sclerosis associated with adenomata, I believe that simple methods of approach must be developed. Special instruments, cystoscopic and otherwise, such as the Stern or Kirwin resectoscope, or the Davis, Bumpus or McCarthy developments of Stern's resectoscope, to treat these cases may be necessary, but if with these point electrodes and with flexible loop electrodes one can relieve these patients of their obstruction, perhaps less dramatically, I believe these newer methods have a better chance of rapid introduction. In addition to the Brown-Buerger operating scope, all one need purchase is various perfected flexible electrodes. Most of us have already the original Bovee set, and are thus prepared to go ahead. In the cases in which I have used these instruments, practi-

cally every one has been satisfactory, except one, and that is probably due to the fact that I have limited myself consistently to cutting out between five and seven o'clock.

In closing I would like to say that I think this is one of the most important diseases we are called upon to treat, and the simpler the instruments and the treatment, the better for us and the better for the patient. Though immediate results are strikingly good, time alone will decide the value of the final results.

Dr. Henry Bugbee: Such a review as Dr. Keyes has given us is of great value in helping to clarify the present status of our technique in handling these cases. To those who have not lived through these years of rapid changes, such a review should lead to conservatism in accepting newer operative methods until a sufficient number of parallel cases have been watched over similar long periods of time.

My own experience dates back to 1906, when, for four and one-half years, while in charge of an active general surgical service, I had the opportunity to operate upon a series of 32 cases of prostatic obstruction, which included 11 cases of sclerosis of the vesical neck or fibrous prostates. These operations were perineal, according to the method of Alexander. The relief of obstruction was too complete in several, in whom incontinence was a prominent postoperative feature.

Following Dr. Beer's use of the high frequency current in the destruction of bladder tumors, both Dr. Stevens and I, working independently, applied this method to the destruction of median bar obstructions and median lobe enlargements. We both published articles during the summer of 1913. In my series of 14 cases the results were sufficiently encouraging to warrant further application, other series being published in 1916 and 1917. The shorter length of time necessary for its accomplishment and the more complete removal of tissue by means of the punch led me to its adoption in these cases.

In draining the bladder suprapubically preparatory to prostatectomy, I noted in a number of cases that following a period of drainage, a supposedly large prostate retracted so that when coming to prostatectomy only a sclerosis of the vesical neck or a small fibrous prostate remained. As it was difficult or impossible to enucleate such tissue, the punch was applied intraurethrally, and under the guidance of the finger in the suprapubic wound, a thorough excision of the obstructing tissue carried out. The functional results obtained were more satisfactory than from other methods previously employed in similar cases, and in 1924 I reported 8 cases so treated.

Since then I have frequently used this technique. Recently, however, I have found that with the removal of one large bite of tissue the vesical neck opens up and a line of cleavage is obtained through which an appreciable amount of tissue, and often definite small prostatic hypertrophies can be removed. An attempt is now made to carry out this line of procedure, whenever the bladder has been opened. The leaving of small hypertrophies leads to a recurrence of the obstruction.

One bladder operated over a year ago, with 61 ounces of residual urine, now empties to 4 ounces.

The possibility of complete bladder drainage, relief of infection, stabilization of kidney function, control of hemorrhage, the removal of a diverticulum or calculus, as well as the removal of a sclerotic prostate in the presence of prostatic calculi, are all elements in favor of this open procedure, and the functional results have been more satisfactory than by other methods heretofore employed.

This method is practically the same as the rongeur method used by Dr. Keyes which has apparently given him his best results.

The possibility of a small amount of residual urine remaining after operation must be borne in mind in these cases and postoperative treatment by dilatation and for the relief of infection is often advisable.

The recent modifications by Davis and McCarthy of the instrument devised by Stern for the intraurethral removal of prostatic tissue by electrocoagulation again present a method which may prove to be the most satisfactory in selected cases.

We will all agree that progress has been made, yet this type of case must still be considered difficult. An open mind based upon broad experience such as that related by Dr. Keyes will go far toward applying the proper treatment in the individual case.

Dr. William F. Braasch (Mayo Clinic): My experience does not go as far back as Dr. Keyes', it is comparatively recent. Much credit should be given Chetwood for his early

contributions to transurethral prostatic resection. Although the end results, as reported by Dr. Keyes, were not very convincing, yet the technique employed today is quite different and I believe will prove to be much more satisfactory. I am inclined to agree with Dr. Beer, however, that much credit should be given to Young for calling attention to the possibilities of transurethral resection by the urethral punch.

The importance of the contributions made by Caulk to this subject should also be recognized, since much of our recent development in the removal of commissural obstruction is due to his efforts. His great contribution was the demonstration, in spite of widespread opposition, that when the obstructing portion of the prostate gland is removed, the rest of the gland becomes markedly reduced, and the obstruction is relieved. He showed that this was equally true when the obstruction was caused either by the median or the lateral lobes.

That type of vesical obstruction generally known as contracted bladder neck is often not simply a cicatricial contracture. The tissue removed in many instances is found to consist in part of adenomatous tissue. A better term for this condition, therefore, would be commissural obstruction. Chronic prostatitis is often observed with marked increase in size of the gland when palpated by rectum. The patient may complain of urinary difficulty and yet on urethroscopic examination but little prostatic tissue may be seen in the urethra which might cause obstruction. When the bladder neck is resected the bladder may drain adequately but the urinary symptoms may not be entirely relieved. Much better are the results obtained with that type of prostatic obstruction where the inflammatory element is not predominant.

Recently progress in transurethral removal of prostatic obstruction has been accelerated by the addition of urethroscopic visualization. With the aid of adequate visualization it is possible to see what tissues should be removed. We have been doing this at the Mayo Clinic for many years, but we did not realize the possibilities of the method until recent contributions had been made. My colleague, Dr. Bumpus, who has done much more work in this field than I have, has made the statement frequently that failure following transurethral section of the prostate gland is caused by removal of too little obstructing tissue.

I also want to repeat another statement made by Dr. Beer in regard to the occurrence of contracture of the bladder sphincter in the female resulting from chronic inflammation. I would like to report 3 cases which I have observed during the past year. This condition may be compared with the contracted bladder neck in the male. It can be relieved by a liberal excision of sphincteric tissue and will be followed by relief. In some cases there is reason to believe that there is also a lesion in the nerve supply of the sphincter muscles. In one of the cases reported excision of sphincteric tissue was insufficient to restore the function of the bladder, which was accomplished by resection of the presacral nerve.

I am quite certain that our methods of transurethral removal of commissural obstruction will change considerably in the next five years.

Dr. Benjamin S. Barringer: One thing which has especially interested me is what Dr. Beer and Dr. Braasch said about Young's idea of contracture of the bladder neck and our knowledge of it. They seem to attribute our entire knowledge of the pathology, the symptomatology, treatment, and cure of contracture of the bladder neck to Dr. Young. I have perhaps an entirely wrong idea, but I think if you look up the published reports of Dr. Keyes and Dr. Chetwood you will find their work antedated Young's by some eight or ten years.

Just one other point. I do not precisely see, and I never have been able to see, that the original Chet vood operation, which was cutting a groove roughly and brutally, but at least cutting a very good groove through the prostate, perhaps 1.5 cm. deep, and not removing any tissue, why the results of that should be so much poorer than the results of the Young punch or the Caulk punch, where a groove much less deep, perhaps 0.5 cm. deep, and yet taking out a little tissue on the side; why the results of that should be so much better than the original Chetwood or Bottini operation I do not understand, but I am inclined to think that the answer to that may be that when we have gathered our cases as carefully as Dr. Keyes has his, and when we take all the operations, by the Caulk method, and the Young method, and compare them,

that the results will turn out to be not much better than the original Bottini operation. Dr. Beer apparently does not agree with me. His results are almost too good. I do not know. I think a very careful estimate of a five or ten year period may give us more light.

Dr. Oswald S. Lowsley: It is a rare treat indeed to hear Dr. Keyes give us a résumé of all modern urology in this regard. A great deal of attention has been directed to the vesical orifice lately by new instruments, new devices, and so forth, and it seems to me that these new developments will find their greatest scope for activity in just this type of case. Sclerosis of the vesical orifice is now usually treated by the new cutting current, which does not leave as large a slough as the Caulk instrument or the Young punch or any of the older instruments, and therefore there is less danger of secondary hemorrhage and that sort of difficulty.

I quite approve of Dr. Beer's insistence on cutting from five to seven o'clock. I think that if one cuts in all directions sclerosis of the vesical orifice is liable to recur, just as it does following prostatectomy if one does not dilate. I think dilatation of the vesical orifice prevents the formation of scar tissue and will prevent postoperative sclerosis in most cases.

Dr. Clyde Wilson Collings: My interest in sclerosis of the bladder neck was aroused by Dr. Keyes in 1923. He started me on the problem of relieving fibrous obstruction through the cysto-urethroscope at that time. Opinions differ on the attack of the fibrous prostate. During my recent visit to Professor Rubritzius's clinic in Vienna, I was told they never do a transurethral operation. It is their belief, that there is always some benign enlargement with the sclerotic bladder neck. Therefore, they do a prostatectomy.

Dr. Beer shares a happy thought with me, and that is simplify the instruments in attacking sclerosis of the bladder neck. I am using the telescope of my cysto-urethroscope (or the panendoscope), a bakelite sheath costing about $18.00, and a loop or knife electrode costing $5.00 or $7.50. In order for electrosurgical instruments to be popular with urologists in general, they must not be complicated or beyond their pocketbook. With this cystoscopic equipment, I am able to remove as much sclerotic prostate or benign enlargement as I see fit. I use the high tension apparatus, and I have found that coagulation takes place at the time of operation. Subsequent bleeding has been minimal.

I have had the same experience Dr. Beer has had in removing small sclerotic areas in the female bladder neck. It is surprising how little one sees urethroscopically, causing the obstruction and residuum. Using the loop or knife electrode, removal of this minimal amount of scar gives a maximal amount of relief of residuum and symptoms.

Dr. Keyes (*Closing*): I did not mention in this brief review the fact that I had used the Caulk punch twice on the bladder neck of women. One of them still has a urethrovaginal fistula.

I think that further advance in understanding these cases will be made by more careful examination of the tissue removed. As stated in my paper, the tissues removed have been examined, but they have been examined in a casual way, whereby we took one, or two, or more pieces of tissue and sent them to the laboratory without any label to distinguish between them; the laboratory picks out one or two of these and examines them, and we may get a surprisingly partial report back. I have thought it would be of much greater interest, and I think it would help us much more in understanding the condition to try and serialize these pieces as they come out at different depths, and therefore clear up more fully in our minds the precise amount of sclerosis in the bladder neck and in the prostate, and the associated adenomatoid lesions. Dr. Braasch remarked that the two sets of lesions were often combined. Sclerosis at the bladder neck of course comes with inflammation at the bladder neck. I have seen cases illustrating infection from so-called grippe, leaving lesions that were merely sclrotic. I have had cases which suggested that lesions at the bladder neck were due to indwelling catheters, and were merely incidental lesions, added to the commissural hypertrophy which was the primary cause of retention. Further pathological observations will go as far as our instrumental improvements in changing our ideas.

FRACTURES OF THE ANKLE*

M. C. Lile, M.D., and L. H. Edmunds, M.D.

SEATTLE, WASH.

THIS subject has been one of particular interest to surgeons and orthopedists alike since the illuminating writings of the English surgeon, Sir Percival Pott, nearly two hundred years ago. While it is true that the type of fracture which Pott described, and the one that bears his name, is a rare fracture, nevertheless it was his work on this subject which furnished the necessary impetus to investigation so that later workers have been able to classify the types of fractures found and their method of production, information which furnishes us with the key to the best method of treatment.

A thorough knowledge of the anatomy and physiology of the ankle joint is essential in treating fractures in this region. The ankle joint is a weight-bearing joint and, as such, is one of the most important in the body, for it bears more weight than any other joint in the body. It works as a hinge joint. Its movements are said to be 20 degrees dorsiflexion and 60 degrees plantar flexion. No lateral movement takes place in the ankle joint proper, but is found in the subastragaloid joint. The joint is formed by the lower ends of the tibia and fibula, between which the astragalus is held as in a mortise. The sides of the mortise are formed by the internal malleolus of the tibia and the external malleolus of the fibula. Strong ligaments hold the mortise together and permit practically no lateral movement. These are the internal and external lateral ligaments and the anterior and posterior tibiofibular ligaments, as well as the interosseous ligament holding the tibia and fibula together. An important point to bear in mind is that a strong band of the external lateral ligament passes to the posterior surface of the astragalus and binds it firmly to the fibula. There is no counterpart to this band on the inner side of the foot, and hence the astragalus remains inseparably attached to the fibula and is displaced with it rather than with the tibia.

Fractures of the ankle always have been and always will be one of the commonest types of major fractures with which we have to deal. In our own series, we find that they come next to Colles' fracture in order of frequency. To quote figures, we have had 69 fractures of the fibula and 95 of the tibia, exclusive of the ankle fracture; 77 fractures of the radius, exclusive of Colles' fracture; 100 fractures of the entire length of the femur; 109 of the entire length of the humerus; 137 fractures of the ankle; and 176 Colles' fractures.[1] In spite of this frequency with which ankle fractures are encountered, it is still true that as a class the results are more unsatisfactory and the percentage of permanent partial disability higher than in almost any other type of fracture with which we have to contend. About one hundred years ago, Dupuytren,[2] the foremost surgeon of his time, speaking of ankle fractures, said: "Under the most favorable circumstances, they almost always leave deformity and lameness, which renders progression more or less difficult or painful." Results to date do not warrant such a pessimistic outlook as this, due chiefly to the advent of the *x*-ray; nevertheless they are sufficiently poor to rate

[1] These figures were compiled about a year ago. They will be higher if brought up to date.

[2] This remark by Dupuytren is quoted in the introduction to the following article: Platt, H. Fractures in the neighborhood of the ankle joint. *Lancet*, 1: 33–39, 1926.

* From the Mason Clinic, Seattle, Wash.

this as one of the most disabling of all fractures.

Fractures of the ankle may be divided into two groups. In the first group are fractures of the lower end of the tibia and fibula. In the second group are fractures of the astragalus. The latter are rare and really do not belong with the classification of fractures of the ankle. Platt, in reviewing 145 of his cases of fracture of the ankle, found only 4 fractures of the astragalus. In our own series, we have found 8 fractures of the astragalus, most of which have been chip fractures, but our discussion here will include only the first group.

Fig. 1A. Fig. 1B. Fig. 1C. Fig. 1D.

Fig. 2A. Fig. 2B. Fig. 2C. Fig. 2D.

Figs. 1 and 2. Anteroposterior and lateral roentgenograms of typical compound Pott's fracture. A and B. Before reduction. C and D. After reduction.

The clinical examination and diagnosis which were stressed so much by Pott and Dupuytren must take a place in the background in modern practice, because of the advent of the *x*-ray. Suffice it to say that in any severe injury an antero-

posterior and a lateral roentgenogram are absolutely essential. If these are not insisted upon, many fractures will go

Fig. 3. Oblique fracture of lower end of fibula without displacement.

undiagnosed until it is too late for proper treatment.

Fractures of the ankle are generally due to some form of indirect violence. According to Ashurst,[1] who has done the most comprehensive work of modern times on ankle fractures, direct violence was a factor in less than 1 per cent of his 300 cases. Four types of indirect violence have been found as causative agents. These may be listed in the order of frequency: (1) External rotation. This is the common type of ankle fracture and was found to constitute 61 per cent of the cases in Ashurst's series. The foot is rotated outward; a torsion strain is placed on the fibula, which breaks it in an oblique or spiral direction into the joint. This is the characteristic lesion, but other fractures may also occur. If the force continues to act, fracture of the internal malleolus or its equivalent, a rupture of the internal lateral ligament, will result, while occasionally a fracture of the whole width of the lower end of the tibia may be found. (2) Abduction or eversion. The astragalus, pressing against the lower end of the fibula, puts a bending force on the fibula, with transverse fracture of the fibula, usually through the surgical neck but sometimes through the malleolus. The internal malleolus is also torn off or the internal lateral ligament ruptured. These constitute 21 per cent in Ashurst's series. (3) Adduction or inversion. The primary lesion is a tearing off of the external malleolus. Continued compression thrust of the astragalus on the internal malleolus leads to compression fracture of the internal malleolus. (4) Compression violence. This results in a posterior marginal fracture of the tibia. A triangular piece is broken off from the posterior margin of the tibia, the fracture line running downward into the roof of the mortise. A painful joint is frequently the result of this type of lesion.

[1] Ashhurst, A. P. C., and Bromer, R. S. Classification and mechanism of fractures of the leg bones involving the ankle. *Arch. Surg.*, 4: 51–129, 1922.

TREATMENT

Platt,[1] in speaking before the British Orthopedic Association in 1925, said:

> I am confident that in the greater proportion, if not all, of ankle joint fractures accompanied by displacement even of the most extreme degree, it is possible by non-operative methods to achieve perfect anatomical position and to insure the highest standard of functional results. One should be prepared to resort to open operation only if manipulative reduction, repeated if necessary, has failed.

This opinion is likewise held by the leading authorities in our own country. We are convinced that open operation on a primary fracture of the ankle is almost never indicated.

The essentials of treatment consist in (1) early and accurate reduction, (2) holding the fragments, and (3) instituting massage and motion early.

[1] Platt, H. Fractures in the neighborhood of the ankle joint. *Lancet*, 1: 33–39, 1926.

Reduction should be done immediately, before the swelling distorts the tissues, as it is accomplished with a great deal more difficulty after the tissues and muscle fibers have become distended with extravasated blood. Early reduction stops pain and prevents further trauma to the soft parts and thus materially reduces the period of disability. An anesthetic producing full muscular relaxation should always be given before attempting reduction. It may be necessary to make several attempts at reduction before a satisfactory position is obtained. This may be somewhat embarrassing to the surgeon, and this embarrassment may even induce him to desist from further attempts. However, it is infinitely better to endure this embarrassment at this time than later, when poor function shows that a good reduction was not obtained. The fluoroscope, where the eye can guide the hand, may be of considerable aid in difficult cases. Reduction is made easier by flexing the knee so as to relax the tendon of Achilles. Dislocations of the astragalus are reduced with the foot in plantar flexion, after which it is forcibly dorsiflexed. Inability to secure dorsiflexion indicates incomplete reduction. Eversion or abduction fractures are then placed in marked inversion to insure contact of the internal malleolus with the tibia. It is important to invert not only the anterior part but the posterior part of the foot, by which the fracture is really controlled. With inversion or adduction fractures, the foot is placed in the neutral position. Overcorrection, which leads to flatfoot, should be avoided. In either instance, the foot should be held at right angles with the leg. With oblique fractures of the fibula and occasionally with posterior marginal fractures of the tibia, it may be necessary to place the foot in plantar flexion to secure an accurate reduction. With posterior marginal fractures, the important point to bear in mind is that the posterior fragment should never be left in such a position that it will in any way interfere with the hinge-like action of the ankle joint. This will sometimes occur if the foot is fixed in dorsiflexion because of the ligaments pulling the posterior fragment below the joint line, in which position it would seriously interfere with joint function. These cases necessitate fixation in plantar flexion, but plantar flexion is a dangerous position for the foot to be left in. As soon as the fracture has set sufficiently to allow movement, ordinarily 10 to 14 degrees, the foot should be brought up into the dorsiflexed position. If left in plantar flexion, contracture of the tendon of Achilles may result, which would lead to a great lengthening of the period of disability and might even lead to a permanent disability.

Fig. 4. Posterior marginal fracture of tibia. This fracture, while simple in appearance, is apt to be disabling.

Fixation is best accomplished by molded plaster splints or a circular plaster cast. The plaster should be molded well around the malleoli and to the arches of the foot. The plaster should extend sufficiently high on the leg to immobilize the knee. If a circular cast is applied, it should be bivalved immediately.

FIG. 5A. FIG. 5B.

FIG. 6A. FIG. 6B.

FIGS. 5 and 6. Fractures of both malleoli, also posterior marginal fracture of tibia, with posterior dislocation of the foot. Fig. 5. Before reduction. Fig. 6. After reduction.

Massage and Motion. Fractures should be immobilized the minimum time for safety. Massage and motion improve the circulation, stimulate the tissues, promote healing, reduce excess callus to a minimum, and tend to prevent joint adhesions and ankylosis. Massage and gentle passive movement may be started not later than the second week and repeated every other day. The entire limb should be massaged, and, needless to say, the massage should always be toward the body. Active motion can be begun at the end of the third week and gradually increased until the full range of motion is obtained. The entire cast can be removed by the sixth to the tenth week, depending on the type of fracture. Weight-bearing is then started. If the callus formed is firm, weight-bearing will be relatively painless. If, however, the callus is still soft, there will be considerable pain on weight-bearing, and this is an indication for postponement of further weight-bearing for ten to fifteen days longer. As soon as weight-bearing is started, the inner side of both the heel and the sole of the shoe should be raised with an Aniston wedge of about 3/8 inch thickness. This is an extremely important point, for it will give great comfort to the patient to take the strain off the ligaments on the inner side of the foot. If this is not done, the foot will gradually work over to the everted or flatfoot position. After the first ten days, the patient should be allowed up and about on crutches. At first the leg will swell considerably because of venous stasis. Consequently at first he should be up for short periods only, and between these periods the leg should be elevated to aid the return of blood. The periods up can be gradually increased, when the leg again becomes accustomed to the dependent position.

Compound fractures, if no infection occurs in the wound, are handled in much the same way as closed fractures after the initial reduction. The wound is cleansed well with ether, which is the antiseptic of choice in these cases. Dirt and devitalized tissue are carefully removed by sharp dissection. Reduction is then effected, torn ligaments sutured, and one or more Penrose drains inserted into the subcutaneous tissue but never into the joint. The wound is closed loosely with skin clips, after which the cast is applied as previously described. Experience with thousands of these cases during the recent World War has shown conclusively that simple but thorough débridement by sharp dissection is far superior to the use of any type of chemical antiseptic which can be applied. If there is no undue pain in the wound and the temperature is not excessive, the dressing is not changed for five days. A window is then cut in the cast, skin clips and drains are removed, and a clean dressing is applied. The wound need not be dressed again until the condition of the patient leads to a suspicion that infection is developing in the wound, as such change of dressing can do no possible good and may even lead to the introduction of infection into an otherwise sterile wound.

The prognosis, of course, depends to a large extent on the type of fracture. Marshall and Reed[1] state that in any case except the slightest crack a disability of three months is not uncommon and frequently the disability is for six to nine months or even longer. The average seems to be between thirteen and sixteen weeks. The records of one state industrial commission show the time lost to be from six weeks to eight months, while the partial permanent disability varies from little or none to 25 to 50 per cent in severe cases.

[1] Marshall, V. F., and Reed, C. C. Fractures of the ankle, with special reference to treatment and return of function, *Wisconsin M. J.*, 28: 300–309, 1929.

TUMORS OF BONE

MALCOM THOMPSON, M.D., F.A.C.S.

LOUISVILLE, KY.

IN 1879 the younger Gross of Philadelphia wrote his memorable work "Sarcoma of the Long Bones." From the time of the appearance of Gross' book until 1920, very little progress was made in the study of tumors of bone. The entire subject was confused by an enormous number of meaningless descriptive terms, and there was complete lack of uniformity and agreement among the students of these conditions. One skilled pathologist would call a tumor a periosteal sarcoma. Another would call the same tumor an osteosarcoma, while another of equal ability would term it a large spindle cell sarcoma![2] It can easily be seen that with such differences of opinion, it was utterly impossible to formulate definite and safe rules for prognosis and for therapy. Tumors of bone are infrequent in comparison to many other diseases. Men of large experience would not see a sufficient number in their lifetime to really speak with authority upon the subject. It is estimated that there is one patient with primary tumor of bone to every 100,000 people at any given time. The ratio of primary malignant tumors to primary benign tumors is approximately two to one. Taking the population of Louisville at 307,000, we may roughly expect today two native Louisvillians with primary malignant tumor of bone and one with benign primary tumor of bone. Naturally, in large medical centers, there are more cases than the figure just given, as patients suffering with this disease come from adjoining communities for diagnosis and treatment.

In 1920 the American College of Surgeons, realizing the lack of definite knowledge on this subject, appointed a special committee to study it. This committee organized what they called a Registry, and invited physicians to register their cases of bone tumor with them. In order to register a case, one simply sent to the committee "a brief clinical history, two or three characteristic *x*-ray prints, and freshly fixed tissue or blocks or slides."[2] Cases in which there had been neither operation nor autopsy could be "registered with the clinical history and *x*-ray prints alone."[2]

Some members of the profession welcomed the committee's invitation and filed their cases with them. With these cases as a nucleus, the committee formulated a nomenclature, which is now the accepted basis by surgeons over the entire country for the study of tumors of bone. The committee fully realized that their classification or nomenclature was far from perfect, but it is certainly the best possible at the present time, and it has both enhanced and facilitated the study of these conditions.

In 1925 E. A. Codman, of Boston, published a small book called "Bone Sarcoma"[2] which was an interpretation of the nomenclature used by the committee. In 1927 Anatole Kolodny, of Iowa State University, published a book called "Bone Sarcoma,"[3] in which he reported his study of 700 cases of the registry. Codman's book is small and can be used for ready reference. Kolodny's book is a masterpiece of material and workmanship, and should be consulted by any one at all interested in this subject. Charles F. Geschicter has recently written a paper, "The Roentgenologic Diagnosis of Bone Tumors," which is a complete and excellent study of the material in the surgical pathology laboratory of Johns Hopkins Hospital. The original diagrams and illustrations make it a valuable reference for anyone attempting to diagnose tumor of bone. In 1930, A.

E. Hertzler of Halstead, Kansas published his "Surgical Pathology of Diseases of Bones." It is a beautiful book in which his extensive experience of over thirty years is recorded. In it he clearly and comprehensively presents the pathology of tumors of bone.

Upon considering the diagnosis of the various tumors of bone, there are certain general studies to be made in every case. When a patient is presented complaining of pain or disability in the extremities or of any other symptom with which there is any possibility of osseous involvement, a complete medical history should be taken. The history of trauma and of infectious disease should be carefully gone into. A thorough physical examination should be made with particular search for the presence of hidden infections. A complete urinalysis (including search for Bence-Jones protein), a complete blood count, and a Wassermann examination of the blood should be made. Anteroposterior and lateral *x*-ray pictures of the part involved are always indicated. If then a condition is found, in which bone is involved and bone tumor is suspected, make *x*-ray pictures of all of the bones of the body and of the chest. With this data at hand, one is prepared to attempt a diagnosis. Until a definite diagnosis is made, the patient should be at rest in bed with the part immobilized. This is important to prevent early metastases.

The classification accepted by the Committee is as follows:[2]

1. Metastatic tumors, primary in tissue other than in bone.
2. Periosteal fibrosarcoma.
3. Osteogenic tumors.
   - A. Benign
   - B. Malignant
4. Inflammatory conditions.
5. Benign giant cell tumors.
6. Angiomata.
   - A. Benign
   - B. Malignant
7. Ewing's tumor.
8. Myeloma.

The characteristics of each one of these tumors will be briefly outlined except the angiomata, which are so rare that consider-

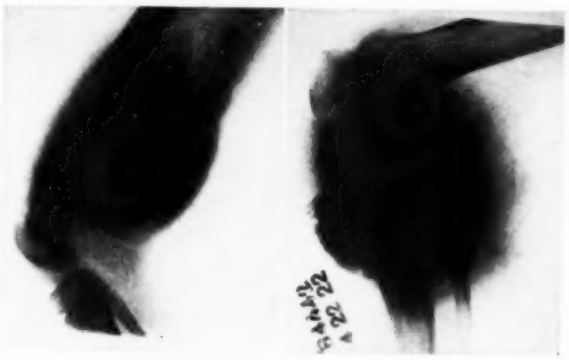

Fig. 1. Fig. 2.

Fig. 1. Early malignant osteogenic sarcoma of femur.
Fig. 2. Advanced osteogenic sarcoma of tibia.

able doubt exists whether they should be given a separate classification or not. Under inflammatory conditions are included many diseases which are not typically inflammatory, but which are likely to be mistaken for bone tumor. Under the heading of "locations," the bones given first are approximately the ones in which tumor is most commonly found.

Unfortunately, very little can be learned concerning the benignancy or malignancy of an osseous tumor from the local physical examination. Many malignant tumors of bone occur without swelling, and some of them without pain or tenderness. I have recently seen a metastatic hypernephroma of the third lumbar vertebra with metastasis to the chest in which there were no local signs or symptoms. Consequently, the complete examination outlined and a knowledge of the natural history of these diseases is of utmost importance.

METASTATIC TUMORS

History: Often a record of having had an operation upon the breast or prostate. Cancer of the thyroid and hypernephroma are frequently "silent"; that is, they are present and unsuspected and often not found except at necropsy. Cancer of the prostate, cancer of the thyroid, cancer of the breast, hypernephroma, and cancer

of the uterus are tumors most frequently metastasizing to bone. Pain is early in onset as a rule and may be present for

Fig. 3. Benign bone cyst of radius and ulna.

months before there is any roentgenologic evidence. Hypernephroma often causes fever.

Rate of Growth: As a rule, slow. Rapidly growing carcinomata usually kill before there is an opportunity for metastasis to bone.

Location in the Body: Upper end of femur, (head is rarely involved), ilium, pubis, all five lumbar and lower three thoracic vertebrae, third to ninth ribs inclusive, skull, upper end of humerus, lower end of femur. According to Nichols, metastatic tumors are uncommon below the elbows in the upper extremities, and below the knees in the lower extremities.

X-ray Characteristics: Central, and practically always multiple, though single ones have been known to occur. Occur in diaphysis, metaphysis, and epiphysis. More frequent in diaphysis. Punched out areas without reaction of the surrounding bone. Metastatic carcinoma of the prostate is an exception in that new bone is sometimes formed around it. In the vertebrae, the intervertebral discs are intact, a point helpful in differentiating from tuberculosis.

Age: This lesion is commonly found between the ages of thirty-five and seventy-five.

Pathological Fracture: A frequent occurrence.

Metastases: Commonly in the chest, a valuable point in differentiation from multiple myeloma.

Effect of Radiation: Depends upon the radio-sensitivity of the parent tumor. Some, very radiosensitive, others, radio-resistant. Radiation should be tried in most cases.

Treatment: Support. Immobilization. Deep *x*-ray therapy.

Prognosis: Hopeless.

PERIOSTEAL FIBROSARCOMA

History: Often a history of trauma. Examination reveals a fixed fusiform mass. Pain is rather constant, though not severe.

Location in the Body: Lower femur, and upper tibia, upper femur, ischium, upper fibula, upper humerus, lower tibia, frontal bone, ribs, and upper radius.

Rate of Growth: Much slower than osteogenic sarcoma.

X-ray Characteristics: Diaphysis is common location. May arise from joint capsule. Single. "A tumor adjacent to bone perhaps causing superficial erosion of the bone, but not starting in the bone."[2] There is no evidence of new bone formation.

Age: Thirty to forty is the most common period. May occur infrequently at other ages.

Pathological Fracture: Very rare.

Metastases: Occur late in the disease.

Effect of Radiation: Very radiosensitive as a rule.

Treatment: Immobilization, radiation, Coley's toxin, and then amputation.

Prognosis: Good if early treatment is instituted.

BENIGN OSTEOGENIC TUMORS
(EXOSTOSES, OSTEOMATA, CHONDROMATA)

History: Tumor generally discovered by patient because of local deformity. Pain rarely an important feature.

Rate of Growth: Very slow May remain stationary for years.

Location in Body: Lower femur, upper tibia, upper femur, upper humerus, phalanges, and all of the other bones of the body with the exception of the patella.

X-ray Characteristics: Metaphyseal side of epiphyseal line. Periosteal and cortical except in the phalanges where chondromata are central. Encapsulated and pedunculated. Single and multiple.

Age: Ten to thirty.

Pathological Fracture: Very rare. Does occur in central chondromata.

Metastases: Do not occur.

Effect of Radiation: Radioresistant.

Treatment: Surgical excision with wide base is method of choice. Apply 50 per cent zinc chloride solution to the base.

Prognosis: Excellent. Incomplete removal predisposes to malignant change; this is particularly true of the chondromata.

MALIGNANT OSTEOGENIC TUMORS

History: Trauma often precedes the onset of growth. Pain is an early symptom, worse at night and upon exercise. Disability is early because of the pain. A palpable mass is soon present. Curiously, both skin and cartilage are resistant to the growth of these tumors.

Rate of Growth: Very rapid.

Location in Body: Upper tibia, lower femur, upper humerus, are the frequent sites. Upper femur, upper fibula, lower humerus, clavicle, ilium, lower tibia, upper ulna, lower radius, and lumbar vertebrae are sometimes involved.

X-ray Characteristics: The shaft through the tumor can usually be visualized. Tumor may begin in medulla or cortex; soon both are involved. Osteogenesis and osteolysis usually present at the same time. Without osteolysis there can be no diagnosis of malignant osteogenic tumor as it is primarily a destructive process. Spicules of bone at right angles to the shaft and outside of it are often seen. Soft tissues are invaded. There are no trabeculae as seen in giant cell tumor. Generally in metaphysis near epiphyseal line.

FIG. 4. Metastatic hypernephroma of femur.

Age: Ten to twenty. Occurs infrequently at other ages.

Pathological Fracture: Common.

Metastases: Early and constantly to the lungs.

Effect of Radiation: Practically all of them are radioresistant. A few do respond somewhat to radiation. Impossible to tell before trying which ones will respond to radiation.

Treatment: Amputation. Then radiation to chest and Coley's fluid.

Prognosis: Rapidly fatal in all but a few cases.

OSTEITIS FIBROSA CYSTICA
(BONE CYST OR VON RECKLINGHAUSEN'S DISEASE OF BONE)

History: Pain is slight and often not present. Is probably due to parathyroid tumors or oversecretion from parathyroids.

Rate of Growth: Slow.

Location in Body: Upper femur, upper tibia, upper humerus, lower femur, lower tibia, middle of femur, middle of fibula, ilium, lower radius, clavicles, metacarpals, metatarsals, and os calcis.

Fig. 5. Ewing's tumor of ulna.

X-ray Characteristics: May be single or multiple. In diaphysis. Does not occur in epiphysis. Medullary with thin cortex, but expansion is not great and often not present. Entirely bone destructive. There are no trabeculae.

Age: Five to forty.

Pathological Fracture: Very common. In the majority of cases, it is the first symptom to attract attention.

Metastases: Do not occur.

Effect of Radiation: Some respond to radiation. It is not the treatment of choice, however.

Treatment: Support. Immobilization. If fracture occurs, treat as any other fracture in that location. Sometimes necessary to curet the cyst and crush inward part of the cortex. Search for tumor of parathyroid and if present remove it.

Prognosis: Excellent.

MYOSITIS OSSIFICANS

History: Practically always a traumatic history. May be a sudden severe sharp blow as received in football or an often repeated slight injury. Slight pain and tenderness are usual symptoms. Definite mass is palpable and in early stages, movable.

Rate of Growth: Very slow.

Location in Body: Brachialis anticus, quadriceps extensor, adductors of thigh, deltoid, and pectoralis major muscles. May occur in tendon as well as muscle.

X-ray Characteristics: New bone definitely parallel to the shaft. Fluoroscopy is of value as the mass is often movable.

Age: Fifteen to thirty-five.

Pathological Fracture: Does not occur.

Metastases: Do not occur. A few cases have been known to recur and later undergo malignant change.

Effect of Radiation: Does not respond.

Treatment: Immobilization. If symptoms persist, surgical excision.

Prognosis: Excellent.

OSTEITIS DEFORMANS (PAGET'S DISEASE OF BONE)

History: Gradual enlargement of skull. Loss of stature. Usually pain in bone early in the disease.

Rate of Growth: Slow.

Location in Body: Tibia, skull, pelvis, femur, vertebrae.

X-ray Characteristics: Multiple lesions. Tremendous widening of bone which has appearance of thickening. Through this thickened portion, there are multiple areas of rarefaction. Anterior bowing of tibia. Lateral bowing of femora. Softening of vertebral bodies. In both diaphysis and metaphysis. Secondary malignant osteogenic changes are common.

Age: Forty-five to seventy.

Pathological Fracture: Not commonly present. Has been known to occur in a few cases.

Metastases: Do not occur.

Effect of Radiation: Does not respond as a rule. Sometimes useful in relieving the pain.

Treatment: Treatment has usually been of no benefit. Marsalet, of Bordeaux, reports remarkable improvement in one case

following administration of irradiated ergosterol and calcium gluconate.[7]

Prognosis: Hopeless in all cases except the one reported by Marsalet.

SYPHILIS

History: Occurs in secondary and tertiary periods of syphilis. May be congenital. Other stigmata usually present. Pain almost always present and severe. Boring pains at night are common. Fever sometimes occurs. Positive Wassermann reaction in most, but not all cases. Skin sometimes involved early which does not occur in bone tumor.

Rate of Growth: Slow as a rule.

Location in Body: Bones of skull and face, tibia, sternum, clavicle, fibula, ribs, phalanges, vertebrae, especially in cervical region.

X-ray Characteristics: May be single or multiple, usually multiple. In any part of the bone, most often in the shaft. "Its commonest manifestations are periostitis and irregular areas of destruction."[4] New bone practically always present. In children, a rarefied band beneath the epiphysis.

Age: May occur at any age.

Pathological Fracture: Rare. Has been known to occur.

Metastases: None.

Effect of Radiation: Not radiosensitive.

Treatment: Antisyphilitic remedies. Rest in bed as long as there is pain. Later local support.

Prognosis: Excellent.

TUBERCULOSIS

History: Usually history of a limp or of pain upon sitting. Night sweats. Often a preceding trauma. Pain is present especially when weight or strain is placed upon the bone. Fever. Tuberculin test positive.

Rate of Growth: Varies greatly.

Location in Body: Vertebrae, upper femur, lower femur, upper tibia, phalanges, and bones of carpus and tarsus.

X-ray Characteristics: Cartilage soon destroyed, which is a valuable point in differential diagnosis. May begin in diaphysis or epiphysis, but soon travels toward the joint. Usually single. Begins in medulla, but soon involves cortex. Entirely

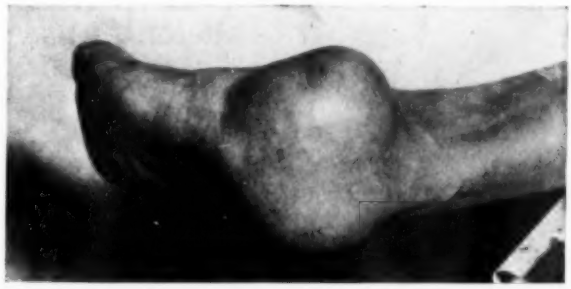

Fig. 6. Chondroma of os calcis. Microscopically not malignant. This illustrates impossibility of diagnosing tumors of bone from physical examination alone. Prompt local recurrence followed excision. Amputation refused. One year later, a large fungating mass extending up leg but no distant metastases.

a destructive process with no attempt at osteogenesis. In the spine destruction of the intervertebral disc.

Age: Three to twelve.

Metastases: None.

Effect of Radiation: Not radiosensitive.

Treatment: Rest, abundant proper nourishment, immobilization, heliotherapy, operation in some.

Prognosis: Fair.

GARRE'S OSTEITIS (SCLEROSING NON-SUPPURATIVE OSTEOMYELITIS)

History: Extremely rare. Onset usually acute. High fever. Painful swelling. "When the acute symptoms subside, the bone is left permanently thickened."[1] Boyd states the etiology is unknown. In a patient of mine severe chronic infection of the tonsils was almost certainly an important causative factor. "Some previous systemic infection such as pneumonia, influenza, or typhoid may be recorded in the history."[4]

Rate of Growth: Rapid.

Location in Body: Tibial shaft, femoral shaft.

X-ray Characteristics: "The affected bone is very dense and the medullary cavity is obliterated."[1] Cortex greatly thickened.

Age: Fifteen to twenty-five.

Pathological Fracture: Does not occur.

Metastases: None.

Effect of Radiation: Radioresistant, but the pain may sometimes be relieved by radiotherapy.

Treatment: Rest. Local applications. Remove foci of infection. My patient was cured by tonsillectomy. Anodynes. Diathermy. Radiotherapy.

Prognosis: Excellent.

BRODIE'S ABSCESS

History: Much more frequent in males than in females. Generally a preceding history of an acute infection in the bone. The abscess is localized as a slightly painful swelling. Typhoid fever often causative.

Location in Body: Upper tibia, lower tibia, lower femur, lower humerus, lower radius, lower ulna.

X-ray Characteristics: Medullary. Entirely bone destructive. Metaphyseal. A rarefied almost circular lesion with thickening of the overlying cortex.

Age: Five to thirty.

Pathological Fracture: Practically unknown in this condition.

Metastases: None.

Effect of Radiation: No response to radiation.

Treatment: Surgical evacuation.

Prognosis: Excellent.

GIANT CELL TUMOR

History: Pain is most frequent and constant symptom and occurs early. Only slight tenderness upon palpation. Swelling practically always present.

Rate of Growth: Slow as a rule.

Location in Body: Lower femur, upper tibia, lower radius, upper femur, upper humerus, lower tibia, vertebrae, both maxillae, inner clavicle, upper and lower ulna, lower humerus, upper and lower fibula, metacarpals, tarsals, and metatarsals.

X-ray Characteristics: Single lesion. Central. Epiphyseal. Expansive. Articular cartilage rarely if ever involved. No periosteal lipping. Layer of spongiosa does not separate tumor from cartilage. Cortex intact. Trabeculae present.

Age: Sixteen to thirty is most common period.

Pathological Fracture: Does occur, but is rare.

Metastases: Very rare. If it occurs there is some question concerning the diagnosis as central chondromata (exclusive of phalanges) do undergo malignant change and they are likely to be mistaken for giant cell tumors.

Effect of Radiation: Only slightly sensitive to radiation and some are definitely radioresistant. Pain persists for sometime after radiation is begun.

Treatment: Adequate curettage plus zinc chloride application is the method of choice. Excision and transplant necessary in a few cases. Herendeen, of New York, recommends radiation.[8] Coley has had good results with his serum.[3]

Prognosis: Excellent if treated properly.

EWING'S TUMOR

History: There is more frequently a traumatic history in this condition than in the other tumors. Symptoms are generally intermittent and fever and leucocytosis are often present. Often difficult to differentiate from an acute osteomyelitis. Pain is an early symptom, often severe.

Rate of Growth: Not as rapid as osteogenic. More rapid than periosteal fibrosarcoma.

Location in Body: Tibia, fibula, humerus, ulna, femur, clavicle, small bones of the feet, ribs, vertebrae, mandible, and skull. Coley has reported one of the metacarpal.

X-ray Characteristics: Shaft of long bones. Medulla and cortex are invaded simultaneously. There is no bone production. Cortex and medulla are swollen and widened. There is a striated appearance of the bone. Soft tissues are invaded.

Age: Ten to twenty.

Pathological Fracture: Rarely occurs and then only in late stages.

Metastases: Frequently in lungs and moderately early. Metastases also occur to

other bones and to lymph nodes and to soft parts.

Effect of Radiation; Very radiosensitive, the most so of any bone tumor.

Treatment: Mobilization, irradiation, Coley's fluid, and amputation. Better results from Coley's fluid in this tumor than in any other form of malignancy. Coley often injects the fluid directly into the tumor.

Prognosis: A few survive the five year period (12 per cent in Geschicter's series). Practically 100 per cent die within ten years. Coley has reported several recoveries over a long period of years, all of which received Coley's toxins.

MULTIPLE MYELOMA

History: Pain an early symptom. Signs of pressure upon the spinal cord often the first manifestation of the disease. Anemia frequently present. Also an incipient fever. Much more frequent in males than in females. Bence-Jones proteins found in many, but not all cases.

Rate of Growth: Some grow slowly; others very rapidly. Most of them grow rapidly.

Location in Body: Skull, sternum, ribs, and vertebrae are most frequent sites. Other areas: clavicles, upper humerus, ilium, upper femur, lower femur. Note that it rarely, if ever, occurs below the elbows and below the knees.

X-ray Characteristics: Multiple lesions. Medullary. May be in any part of the bone. Punched-out areas of destruction of bone. No evidences of new bone formation.

Age: Forty to sixty.

Pathological Fracture: Very frequently the first symptom. Crushing of vertebral bodies is often seen.

Metastases: Generalized metastases are common but rarely metastases to lungs, a most helpful fact if differentiating from metastatic carcinoma. The metastases may be early or late.

Effect of Radiation: Very radiosensitive.

Treatment: Immobilization and support to prevent fracture. Deep *x*-ray therapy. Coley's toxins.

Prognosis: Hopeless for cure. Life often prolonged comfortably with *x*-ray.

Rachitis, scurvy, osteochondritis juvenilis, achondroplasia, fragilitas ossium, osteomalacia, and acromegaly are not described as they seldom, if ever, simulate tumor of bone.

The *x*-ray plates and photograph were made by Dr. Clyde McNeill and Dr. W. C. Martin. Dr. McNeill has also offered many valuable suggestions. The writer is most grateful for these favors.

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CLINICAL OBSERVATIONS IN THE USE OF ULTRAVIOLET IRRADIATED PETROLATUM

EUGENE H. EISING, M.D.

NEW YORK CITY

DURING the past two years, the use of ultraviolet irradiated petrolatum has been applied to a great variety of conditions, far exceeding those originally found to be benefited thereby and as a result a vast amount of clinical data has come to the hands of the writer.

It is quite impossible to estimate with any degree of accuracy the number of cases in which irradiated petrolatum has been used, but several hundred written case reports attest the usefulness of the product and demonstrate its superiority in a large variety of chronic and intractable surgical conditions that have resisted all other therapeutic measures.

The purpose of this paper is to describe its clinical action in a few average cases, without any attempt being made to review the many conditions in which it has been satisfactorily used.

The development of this preparation is the result of clinical research, based upon the discovery that petroleum derivatives, after irradiation with ultraviolet light, acquire certain remarkable therapeutic properties. The exact nature of the chemical change produced by irradiation is not completely understood.

When petrolatum is exposed to the action of ultraviolet light, it becomes photo-active, acquiring the property of acting upon a photographic plate, in such a manner that when the plate is developed, an image or outline of an interposed object will appear. This photo-activity following ultraviolet irradiation is shared by many oils, but only a few of such photo-active oils have been found to possess therapeutic properties. The exact relationship existing between the photoactivity and the therapeutic value has not been entirely established. The photo-activity is now known to be due to the emanation of heavy gaseous vapors which affect a photographic emulsion, and not to true actinism.

Beside photo-activity, petrolatum and certain oils of high viscosity, after ultraviolet irradiation, have been found to acquire bactericidal properties[1,2] but this action alone is not believed to be responsible for the profound effect upon the processes of wound healing.

Ultraviolet irradiated petrolatum slowly but definitely eliminates infection and greatly stimulates the growth processes necessary for tissue repair and it is these combined effects upon which the therapeutic values seem to depend.

It has frequently been observed that when an extensive suppurating wound was flooded with warmed irradiated petrolatum, at the next dressing the nature of the discharge was completely altered and the bacterial count was greatly reduced. After the second application the discharge was often entirely absent and the wound practically bacteria-free. In our present understanding of the phenomena of the control of wound infection and of wound healing, it is impossible to evaluate accurately the bactericidal from other factors in the process. It seems almost certain that the effect of irradiated petrolatum in the wound must be due to some factor beside that of bactericidal activity.

The stimulus to cell production, resulting in the rapid formation of healthy granulations and epithelization seems to be due to the formation of new chemical bodies in the petrolatum. It is well known that ultraviolet irradiation of mineral

oils causes polymerization of certain hydrocarbons contained in the oils. Polymerization is a process of synthesis, in which certain hydrocarbon molecules unite with others of the same kind and form new chemical compounds differing from the former in chemical and physical properties. These newly formed bodies appear to be stereoisomers and have the characteristics of the sterols.[4] It is quite likely that the action of irradiated petrolatum is due to the effect of an irradiated sterol.

That such is the case is strongly indicated by the following: If a highly refined colorless medicinal oil (Squibb lq. petrolatum) is tested by means of the Liebermann-Burchard test, which is the test commonly employed for the detection of sterols, it will be found to be negative. If now this same oil be irradiated for a period of from two to four hours, it will be found to react positively to that test, demonstrating the formation of a new chemical body of the nature of a sterol.

Sterols are widely distributed in nature and are concommitants of life processes in both plant and animal. Their physiology is not understood. Ultraviolet irradiation renders some of them isomeric and imparts to them new properties which they did not possess before irradiation.

Doubtless, in the exposure of the surface of the body to the effects of artificial ultraviolet light the latter exerts its activity through a similar agency by acting upon certain oleaginous constituents of the penetrable layers of the integument.

CLINICAL OBSERVATIONS

The clinical use of irradiated petrolatum has found a wider field of application than had at first been anticipated.

It has been used extensively in infected wounds of the soft tissues, such as cellulitis and postoperative wound infections, in infections of the tendon sheaths, in sinuses such as persist after appendicectomy and cholecystectomy, in fistula-in-ano, in chronic bone sinuses and osteomyelitis, in varicose, decubital and diabetic ulcers and in various cutaneous affections.

In use, it has been found a convenient practice to fill a large urethral syringe with the molten petrolatum ready for use, and before using, to liquefy the mass by allowing hot water to flow over the syringe.

It is advised that no gauze drains be placed in the wound and that the overlying gauze be not bandaged too tightly as in such case the petrolatum is squeezed out of the wound.

The following is a partial list of cases that have been treated with irradiated petrolatum. A number of the cases have been treated by the writer, many of them have been treated by other physicians and have been observed by the writer and still others have been reported either verbally or in writing. Quotations from written reports will be cited. No attempt at detail is intended.

84 CASES OF POSTOPERATIVE ABDOMINAL WALL SUPPURATION

These wounds became infected, followed by more or less extensive breaking down. In many of the cases the entire wound lay open with sloughing fascia and pocketing, the floor of the wound being bowel, covered by granulating peritoneum. Some were small sinuses such as follow drainage for appendiceal abscesses or chronic sinuses persisting after cholecystectomy. These latter sinuses usually closed completely after one or sometimes two injections of irradiated petrolatum, after persisting for weeks.

In the more extensive suppurations, the open wound would be flooded with warmed irradiated petrolatum and covered with the usual gauze dressing. The following day the same application would be made, occasionally a two day interval was interposed. After twenty-four hours, the discharge would be greatly diminished or entirely absent. After the second or third dressing, the wound would be free from discharge, sloughing fascia and nec-

rosed fat was found to have been mostly dissolved and healthy granulations had appeared. No gauze drains should be inserted in the wound. After two or three or sometimes four applications, the wound will be found sufficiently clean and free from discharge to allow of closure with deep silk worm sutures. In every case much time was saved in the healing. In some cases the wound was sutured four days after the first application and the patient sent home with a closed wound ten days after the beginning of treatment.

Case of Dr. J. J.: "Another case was one of ventral and umbilical hernia in a very obese woman, on whom I had to do extensive dissection. The wound became infected throughout and there was profuse seropurulent discharge which promptly improved after several injections of irradiated petrolatum. The time of healing was shortened by many weeks."

Case of Dr. J. R.: "An extensive gangrenous lumbar wound followed pyelotomy for renal calculus, with a deep subdiaphragmatic pocket; the patient was very septic and three weeks after the operation death seemed inevitable. Treatment with irradiated petrolatum was begun. After forty-eight hours the sepsis was markedly diminished, and the wound showed a great change in appearance. Large sloughs came away and the foul discharge had become odorless and scanty. Minute red granulations were seen in many places where the sloughs had been before. At the end of one week, a great change had come over the patient's general condition and the wound was in a healthy condition. Healing continued and the patient was out of bed two weeks after the beginning of the use of irradiated petrolatum and discharged at the end of another week."

Case of Dr. A. S.: "The most remarkable result with this kind of treatment, I had with a case of vesico-abdominal fistula which had been operated upon twice by another physician, without success and which, when I saw the patient, was about the size of a twenty-five cent piece. After having tried the usual methods, I employed irradiated petrolatum and to everybody's great amazement, the wound healed up and had closed permanently inside of two weeks. Patient was in my office to-day (over three months since she was cured) and is in splendid condition."

GRANULOMA INGUINALE

Three cases were reported, all cured.

Case of Dr. J. L. C.: "A negress thirty-six years old. Wassermann neg. Had large deep linear ulcer 5 inches long and ¾ inch wide, occupying groin and extending to perineum. Labium was not involved. Duration two and one-half years. Mercury, iodides and tartar emetic had been used without improvement. When seen, surface was red and covered by granulations which bled readily. A thin watery fluid exuded which had a fetid odor. Donovan bodies were found. After six weeks' application, twice daily, of irradiated petrolatum, complete cure was established."

TENDON SHEATH SUPPURATIONS. (TENO-VAGINITIS)

Seven cases were reported.

These were all serious cases of tendon sheath infection, four occurring in the tendon-sheaths of the fingers and palm of the hand and three of the tendons of the foot and leg. In two of the cases the organisms were Staphylococcus aureus and in four, Streptococcus hemolyticus. The cases were all treated in the same manner. At the time of operation, warmed irradiated petrolatum was deliberately flooded into the open tendon sheaths. No drains of any kind were used, a gauze dressing was applied. The temperatures of these patients, which ranged between 102–104°F., came down promptly after the operation. At the first dressing, twenty-four hours after the operation, there was not a drop of pus to be seen in any of the cases. There was no extension of the infection as is so frequently seen in this type of infection. Granulation and healing followed quickly. Throughout the experience of the writer, with the use of irradiated petrolatum, there is no more striking demonstration of the bactericidal action of irradiated petrolatum than in tendon sheath infections.

Case of Dr. H. L.: "Acute tenovaginitis of flexor tendons of hand. Organism: Streptococcus hemolyticus. Operation: Incision exposing about 2 inches of tendon. Opalescent pus

containing hemolytic streptococcus. No packing. Wound filled with warmed irradiated petrolatum. Operation in two stages: first on finger, second in palm. Symptoms rapidly cleared. Not a drop of pus throughout healing and patient out of hospital within two weeks."

Subsequent report from Dr. H. L. "I am writing just to say that I have had another case of early phlegmon of the foot which was widely incised and treated exclusively with irradiated petrolatum. Instead of the usual sloughing and purulent discharge which accompanies such conditions, the wound healed without any discharge, strange as it may seem, and very quickly."

CHRONIC OSTEOMYELITIS

Eighteen cases have been treated or observed by the writer.

There is no treatment so satisfactory for this disease, if it is intelligently employed. An extensive osteomyelitis involving the entire length of a long bone and discharging through a small sinus cannot be treated through the small sinus. In such case, a preliminary operation is necessary in order to provide means to enable the petrolatum to reach all foci of disease. If the involvement is not extensive, a cure can be established by treatment through the small sinus. Petrolatum acts as a lubricant and aids in the extrusion of sequestra; these sequestra, if they are not interlocked, will be speedily expelled.

In the treatment of bone sinuses leading down to a more extensive area of diseased bone, best results have been obtained when provision was made for the escape of retained exudate.

After thorough saucerization, the bony trough should be flooded with molten irradiated petrolatum and a dry dressing applied. This dressing may be repeated daily. Heat applied through the bandage, either by means of an electric pad or a therapeutic lamp, liquefies the petrolatum and encourages its penetration of the Haversian canals and canaliculi.

In extensive cases, treatment must be persisted in. The discharge soon becomes scanty and granulations begin to appear on the surface of the bone.

In chronic caries of the rib, 3 cases have been reported cured, after one or two injections.

One case of a persistent sinus over one year after operation for osteomyelitis of the shaft of the humerus healed after two injections. One case of osteomyelitis of the pelvic bones that had persisted for five years, discharging through a sinus at the crest of the ilium, healed completely after three months' treatment. Two cases of compound fracture of the tibia, with protruding bone, were treated by this method and unusually rapid healing ensued. One case of traumatic amputation of the thigh with bone protruding into the open wound was treated with irradiated petrolatum, the protruding bone became covered with granulations, and the entire wound was closed in three weeks. A similar case of protruding phalanx has been reported, in which amputation was contemplated. The protruding bone became covered with granulations and then by epidermis in three weeks.

Case of Dr. B. S.: "A chronic sinus 2½ inches long, leading down to a carious rib. This sinus had been present for many months when an injection of irradiated petrolatum was made. When the patient was next seen, three days later, a probe was inserted to test the patency. The probe passed easily into the sinus. Another injection was made and when the patient was seen again, the sinus was closed."

Case of Dr. L. C. C.: "I have used irradiated petrolatum on one case only, that of a persistent sinus following an operation for osteomyelitis of the shaft of the humerus. Sinus had been present about one year and after two injections of the irradiated petrolatum it healed."

GAS BACILLUS INFECTION

One case only was reported.

Case of Dr. C. G.: "A case of traumatic compound fracture of the leg. On the following day, rapidly spreading gas infection with crepitation up to the thigh. Antitoxin was given and amputation at mid-thigh performed.

The wound was left open and Dakin's solution used. Daily cultures from the wound showed persistence of Welch bacillus. Other antiseptics were then used and positive cultures continued. As a last resort, irradiated petrolatum was applied to the open stump. After forty-eight hours the culture was negative."

EMPYEMA SINUSES

No reference is meant herein to chronic empyema sinuses of years' standing with leathery non-collapsible walls. The empyema sinuses referred to, in which this treatment has been employed, were of fairly short postoperative duration. In one case, in a child, two months after rib resection, the sinus showed chronic tendencies. The discharge was profuse, the cavity was large and the lung refused to expand. The child was placed in a pendant position and the cavity was filled with warmed irradiated petrolatum, at intervals of five days. After the third treatment no further injections were made because the wound showed a decided tendency toward healing. One week later, the entire sinus was closed and has remained so. One adult male and two adult females were similarly treated. The duration of convalescence was greatly diminished.

Case of Dr. H. L.: "I have used irradiated petrolatum in many cases, mainly sinuses of long duration in the chest, with excellent results, sometimes almost magical. For example, in one case, a chest sinus which had followed an operation for empyema, was present for more than six months and closed immediately after one injection to open again in three weeks and then to close permanently after one more injection."

CARBUNCLE OF BACK OF NECK

Six cases were reported.

Case of Dr. M. G.: "This case was a large indurated mass with multiple foci of infection and would have required gridiron incisions or total excision. Application of irradiated petrolatum aborted the infection and terminated the progress of the necrotic process. No incisions were necessary. Discharge occurred through the small multiple foci and healing was established in two and one-half weeks."

ULCERS (VARICOSE, TROPHIC, DECUBITAL, DIABETIC)

Many excellent results have been reported in the treatment of varicose ulcers by means of irradiated petrolatum.

Case of Dr. L. B. S.: "A case of varicose ulcer of the leg that had been present for a period of twenty-five years and continuously under treatment, was healed for the first time in all those years after four weeks of use of irradiated petrolatum."

Case of Dr. K. F.: "A varicose ulcer of the leg. Patient had it for twenty years, was completely closed after a few weeks of treatment."

Case of Dr. L. H.: "One case of a large embolic ulcer, in a girl with vegetative endocarditis. The ulcer appeared very suddenly and occupied an area 4½ inches in diameter over both buttocks and sacrum. The necrosed tissue was foul and ill-smelling and other patients refused to remain in the room. This large mass of sloughing tissue did not come away spontaneously and had to be excised. A large gangrenous fetid ulcer remained, that refused to heal." The writer was asked to use irradiated petrolatum on this case. "The fetor disappeared in twenty-four hours, the gangrenous edges disappeared, granulations appeared promptly and the entire area was almost completely closed after ten days of treatment."

Case of Dr. F. M. A.: "I have had under my care for several years an elderly woman with mild diabetes and with circulatory trouble in her legs which seems to be not the usual diabetic arteriosclerosis but rather a thromboangiitis obliterans. She was doing fairly well under treatment when she received a slight injury to one foot, with the result of gangrene and unavoidable amputation in the thigh. At the time of this operation, probably due to some trivial traumatism, a blister developed on the remaining foot and progressed into an ulcer. As this leg had been worse than the amputated one, I rather expected another amputation to become necessary. The ulcer was about the size of a quarter and extended to the depth of the skin but not into the muscle or tendons. With strict control of the blood

sugar and simple local treatments, the ulcer ceased to progress but remained absolutely stationary for over nine months. Severe pains continued in the ulcer and in the leg, requiring sedatives every night. At this point, three and one half months ago, daily dressings with irradiated petrolatum were begun, applied by the nurse at home. Immediately improvement was reported, but I was not impressed until a healthy tendency became unmistakable. The ulcer is now practically healed, only a very slight area remaining to be covered with epithelium. There are no pains about the ulcer, but the ischemic leg pains continue in milder form not requiring sedatives."

Many cases of decubital ulcers have been reported.

Case of Dr. S. G. S.: "The case was an elderly male suffering from cirrhosis of the liver, far advanced, ascites, etc. The patient was confined to his bed and developed two decubiti, one over the sacrum 3 inches in diameter, the second over the right hip 2 inches in diameter. Ordinary dressings had no healing effect and after two weeks use (twice daily) of the irradiated petrolatum, both of the decubital areas were entirely healed with new epithelium."

Case of Dr. N. C.: "A chronic ulcer of the breast following the use of radium needles for a non-malignant tumor. This painful ulcer, the size of a twenty-five cent piece, resisted all treatment for six months. Ten days after treatment was begun with irradiated petrolatum the entire ulcer was closed and pain had disappeared."

PERFORATING DIABETIC ULCER OF THE FOOT

One case after persisting for one and one half years, required a small incision prior to treatment, was cured in three weeks. Another case of perforating ulcer of the foot that had been present for many months, in a diabetic, was healed in four weeks.

Case of Dr. E. R.: "A woman who has been suffering with diabetes mellitus for about twenty years, developed an infected toe. The infection was already in existence about three weeks before I was called to see the patient. I found a markedly swollen little toe, with pus exuding from a small opening in front. A small probe could be inserted through this opening, leading toward bone for a distance of about ½ inch. Two injections of irradiated petrolatum healed this sinus and the inflammation subsided very quickly thereafter."

The purpose of this paper is to present experiences of the writer, together with those of others, in the use of irradiated petrolatum, for the healing of various types of chronic and intractable surgical wounds that have resisted other therapeutic measures.

Note: In two previously published communications the therapeutic, physical, chemical and bacteriological properties of ultraviolet irradiated petrolatum have been discussed.

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DIOTHANE: A NEW LOCAL ANESTHETIC*

CLARENCE G. BANDLER, M.D., F.A.C.S.

NEW YORK CITY

ABOUT a year ago, at the suggestion of Doctors Gordon McKim and Parke Smith of Cincinnati, Ohio, a supply of diothane was placed at my disposal by its originator, Dr. T. H. Rider. Diothane is a research product, being a derivative of phenyl urethane. The pharmacological name of this compound is the hydrochloride of piperidinopropanediol diphenylurethane.

Diothane occurs as dull white, fluffy needle crystals, melting at 195.6°. The crystals dissolve slowly in water to give a saturated solution which, at room temperature, has a concentration of 1.03 per cent. Solutions of 1 per cent and 0.5 per cent have a pH value between 5.1 and 5.6. Such solutions are perfectly stable for indefinite periods when prepared and stored in non-alkaline containers. Alkalies precipitate the anesthetic free base, and minute traces of alkali present in a solution will, in time, lead to a deposition of crystals of the free base.

Additional chemical data have been published elsewhere with great accuracy by Dr. Rider.

At the annual meeting of the American Urological Association held in Toronto, Canada, in June, 1932, Dr. Gordon McKim presented the first clinical experiences with diothane as a local anesthetic in urology. I had the privilege of discussing this paper and narrated our brief experience up to that time at the New York Post-Graduate Medical School and Hospital.

Diothane in 0.5 and 1 per cent solution has been used by all of the members of the department of Urology in private practice as well as on service cases, and these statements represent a concensus of opinion. We have employed diothane solely by urethral and vesical instillation of 20 and 30 c.c. and have waited at least five minutes and preferably ten, before beginning any instrumentation. We have also regularly employed diothane on a meatal plug as an adjuvant to caudal and sacral anesthesia with novocaine.

In this way, diothane has been used in patients varying from eight to eighty-nine years of age during the past year. At this point, I would like to state that, in our department, we do not employ local anesthetics routinely for urethrovesical instrumentation or for cystoscopy for pedagogic purposes. For years we have insisted upon a reasonably delicate instrumental technique, so that anesthetics have been used only when precisely indicated. However, I must say that diothane has proved to be such a useful agent that it is now used routinely for all cystoscopic examinations of private patients.

VARIETY OF CASES

We have found diothane ½ per cent adequate for anesthesia in all of our cases except at the meatus where 1 per cent is preferable. After instillation, ten minutes should elapse before instrumentation. Innumerable patients, apprehensive of cystoscopic examination, have been successfully examined without any discomfort. I would like to mention two specific cases which are reasonably noteworthy.

Dr. S., a victim of recurring vesical papillomata over a period of fourteen years, has been cystoscoped on a great many occasions by me and a few times by other urologists. He had had nitrous oxide-oxygen anesthesia for all diathermy treatments and for most cystoscopic check-ups. Under diothane ½ per cent anesthesia in the bladder and urethra, I diather-

* Presented before the Section on Genito-urinary Surgery, N. Y. Academy of Medicine, Nov. 16, 1932.

mized two small recurrences and have since cystoscoped the doctor and on neither occasion did he experience any pain; in fact, he stated that he did not believe cystoscopy could be performed with such freedom from discomfort.

Mrs. F., aged eighty, has suffered from vesical polypsis, according to Heitz-Boyer, for a number of years and has been treated by him with high-frequency electricity on several occasions, each time under inhalation anesthesia. I, too, cystoscoped her previously under gas-oxygen. Recently I cystoscoped her on two different occasions, each time with ½ per cent diothane in her bladder, and she had no discomfort; in fact, she wanted to know why she had been "put to sleep" for her previous examinations.

Meatotomy has been done a number of times. Internal urethrotomy also has been performed with diothane ½ per cent anesthesia. Papillomata of urethra and bladder have been diagnosed and successfully treated. Gradual dilatation of urethral strictures has been greatly facilitated. Instrumentation after external and internal urethrotomy has been eased immeasurably, as well as with marked diminution in evidences of traumatism. Patients with prostatic obstruction, especially in that type due to carcinoma, have been much more easily examined. Where catheterization of ejaculatory ducts is necessary, diothane urethral anesthesia has minimized instrumental difficulties. Cystitis with its coincidently irritable bladder has been considerably relieved by diothane, and cystoscopy has been much more readily tolerated. In a few patients with urinary tuberculosis, diothane has made cystoscopy feasible, whereas many of these patients heretofore had to have caudal anesthesia.

One patient with a most intractible cystitis, with a markedly contracted bladder, due to tuberculosis, had her frequency and dysuria considerably ameliorated by instillations of diothane 1 per cent t.i.d. over a period of several weeks.

An outstanding case was that of a man sixty-eight years old, with vesical neoplasm and a rectal polyp. Under diothane ½ per cent, meatotomy was performed and, through a #28 French panendoscope, the bladder growth was diathermized, after which the rectal polyp was removed. The entire procedure took forty-five minutes, during which time the patient had no discomfort and was completely cooperative.

Needless to say, we have employed diothane in every type of urologic examination in which anesthesia is customarily used and have found it uniformly successful. In well over 300 patients, we have found no evidence of toxicity, nor have we encountered any individual idiosyncrasy to the drug. A noteworthy action, I believe, is the duration of anesthesia up to an hour and prolongation of analgesia in many cases for another hour. This so-called "postoperative analgesia" is exceedingly grateful to patients as it minimizes and usually relieves the frequency and dysuria immediately following any elaborate urethrovesical examination. We have had very little experience with diothane in local infiltration anesthesia. However, McKim and Smith report many operations for varicocele, hydrocele, hernia, as well as circumcision and cystoscopy with perfect anesthesia over an adequate period of time. It is absolutely essential, even in infiltration anesthesia, to wait for ten minutes for a suitable and complete effect.

Another illustrative case of the efficacy of diothane follows:

V. C., fifty years of age, suffered from recurrent vesical papillomata. This patient, while most cooperative, was cystoscoped with difficulty because of great bladder irritability. He would void alongside of the instrument on moderate distention of the bladder. Besides he showed marked evidence of toxicity from novocaine when this was employed either locally or for caudal anesthesia. On two occasions, with 30 c.c. of diothane ½ per cent in the bladder and urethra, he was cystoscoped and the recurrences were thoroughly diathermized, the procedure lasting for forty minutes each time. There was no tendency to void during the examinations and the patient stated that he had never experienced so little discomfort. Besides, the analgesia after instrumentation lasted so long that there was no undue micturitional frequency.

(Concluded on p. 267.)

THE USE OF

LARGE-CALIBER TUBES IN THE CLOSED METHOD OF DRAINAGE IN EMPYEMA

RALPH B. BETTMAN, M.D.

CHICAGO, ILL.

THAT some form of the closed method of drainage of acute empyema is the most desirable treatment for this condition needs no discussion. Ever since Graham and Bell, in their work for the Empyema Commission of the American Army during the War, pointed out the dangers of the open method of drainage in acute empyema, the closed method of treatment has become more and more in vogue. When one considers, furthermore, that in the closed method of drainage one has the means of actually expanding the collapsed lung and, thus, hastening the obliteration of the empyema cavity, the desirability of the closed method becomes still more striking.

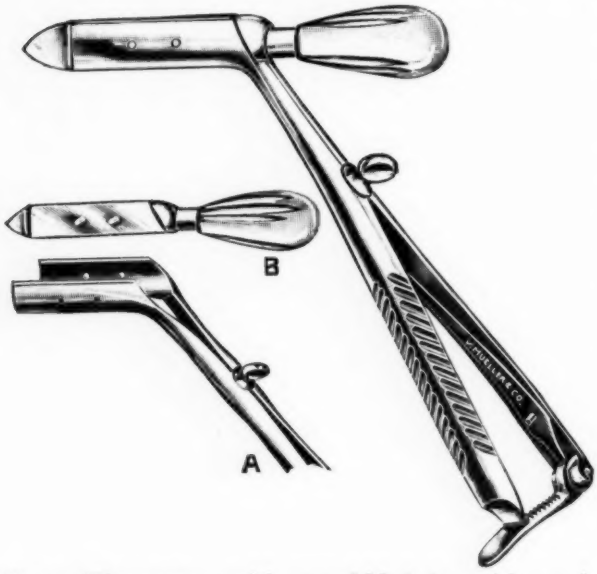

FIG. 1. Thoracotome with central blade in position and with central blade removed.

One of the greatest drawbacks to the closed method of treatment of empyema has been the fact that the comparatively small-bored tubes used have become easily plugged with masses of fibrin, almost always found in the empyema contents. The larger the internal diameter of the drainage tube, the less the possibility of stoppage of the tube. In order to use very large tubes, a portion of one or more ribs would have to be removed. However, it is possible to make use of drainage tubes of much larger diameter than are usually used in the closed method, without sacrificing the simple procedure of intercostal incision. For the last year, I have been using the technique about to be described with very satisfactory results.

An intercostal thoracotomy is performed at the chosen site. I have made use of a modification of the Forvash thoracotome to do this. The thoracotome is an instrument somewhat on the order of a bivalve vaginoscope or proctoscope, the blades being almost flat, about 1 cm. in width and about 6 cm. in length. A third detachable blade fits between the two. This blade projects slightly beyond the other two and has a sharp pointed edge. The instrument, with the central blade in place and the two outer blades closed, is, in fact, a flattened trocar and is used as such.

For drainage tubes, I use large, soft rubber, Pezzer catheters, F.20, F.24, or F.26. In order that the rib above and below will not compress the tube, I insert into the lumen of the catheter a thin-walled silver cannula, from 1½ to 2 inches long, with a bore slightly larger than the bore of the catheter. The silver cannula is inserted into the mushroom end of the catheter, so that it lies a few millimeters from the head, and is held there by one or two silk stitches which pass through the

small perforations which have been placed in the cannula for that purpose, as well as by the elasticity of the rubber itself. The Pezzer catheter, with the inlying cannula, is then sterilized.

The procedure is simple: the site of drainage is selected as ordinarily; the skin over the interspace chosen, the interspace as well as the pleura itself is anesthetized with novocaine solution, and, at the same time, the final exploratory puncture into the pleura (which should precede any operation for acute empyema) is made. With a sharp scalpel the skin is incised for a length sufficient to admit the blades of the thoracotome. The thoracotome is then grasped, just as one would a trocar, in the palm of the hand with the forefinger projected to act as a guard against too deep a puncture, and is gently but firmly pushed through the intercostal space into the empyema cavity, with the blades parallel to the course of the interspace. When the pleural cavity has been reached, the blades of the thoracotome are quickly separated, the median blade or obturator is removed, and the Pezzer catheter with the silver cannula in place is immediately pushed into the empyema cavity, the distal end of the Pezzer catheter being closed with a clamp. With a little practice, this can be done in a fraction of a second so that practically no air will be sucked into the pleural space while the tube is being inserted. As soon as the Pezzer catheter is in place, the thoracotome is removed. If necessary, one small skin stitch of silk can be used to close the wound about the catheter. The catheter is held in place by adhesive as well as by its mushroom shape. In this way, a soft rubber drainage tube, which is non-collapsible and yet is of comparatively large bore, can easily be introduced into the empyema cavity by a very simple and, if necessary, bedside procedure. The subsequent technique of closed drainage has been so thoroughly and so frequently described by others and by myself,[1] that it is not necessary to go into details here.

In certain patients, in whom the ribs are very close together, it may not be possible to employ these comparatively large Pezzer catheters even with the use of the thoracotome, without resecting a small portion of rib. In such patients, and if it is advisable to use large-bore drainage tubes, I first resect a small portion of rib, ¾ inch in length, leaving the pleura intact, and then make use of the thoracotome to perforate the posterior periosteum of the rib and the pleura.

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PULMONARY DIAGNOSIS WITH USE OF IODIZED OILS

HENRY I. GOODMAN, M.D.

NEW YORK CITY

WHEN lipiodol was introduced by Forestier and Sicard in February, 1923, a new era in radiological diagnosis began. Probably in no other field in diagnosis has its usefulness been more proven than in the study of pulmonary diseases. The use of radiographic contrast media in pulmonary diseases began practically with the introduction of bismuth powder insufflations by Jackson, Lynah, and others through a bronchoscope. The difficulty of the technique and the uncertainty of the method soon discouraged any extensive use of it in the diagnosis of pulmonary lesions. With the introduction of an oily medium containing 40 per cent iodine in poppy seed oil in organic combination, a new impetus was given to the radiographic study of bronchial and pulmonary pathology.

Various methods for the introduction of lipiodol were studied. There were four methods:

(1) Through a bronchoscope as advocated by Jackson, Clerf and Ballon. In the hands of experts this method is the most reliable. The information obtained by bronchoscopy is very often of basic importance in determining the type of treatment required. This method requires real skill. Consequently, its usefulness as a universal method is somewhat limited.

(2) Singer's aspiration method has sometimes been effectively used. This method often fails and requires considerable and intelligent cooperation on the part of the patient.

(3) The transglottic method. This method is almost as accurate as the bronchoscopic method but requires skill in laryngeal technique.

(4) Through puncture of the cricothyroid membrane. This procedure has been used by the author in 190 cases with entire satisfaction. In not a single instance was there any evidence whatever of mediastinitis, subcutaneous emphysema or chondritis. In only one case did a superficial infection in the soft parts at the site of puncture develop. This complication was attributable to faulty technique.

The preparation of the patient for lipiodol injection is of paramount importance. In a very nervous type of patient, it is well to administer a mild sedative before the injection is attempted. The patient is urged to cough and bring up as much expectoration as possible. Careful notation is made of this amount of sputum. The amount of lipiodol to be used should be determined by the volume of the expectoration. It is therefore better to make this injection in the morning shortly after the patient has begun his expectoration and in this way cleared his bronchi of secretion. When these injections were first performed, an ordinary 17 gauge needle was used. It was noted that in some cases where the patient had suddenly changed the position of his neck that some lipiodol escaped about the peritracheal tissues and into the mediastinum. As already stated, no mediastinitis was ever noted. The technique has now been improved by a right-angled cannula of special design of 17 gauge, introduced by a tiny trocar as shown in the illustration. The soft parts are always infiltrated with novocaine followed by the direct injection of a few drops of 4 per cent cocaine into the trachea. After the right angled cannula has been introduced, a small flange is screwed on to the cannula. The flange is then secured by a strip of adhesive tape to the skin. The patient is then placed under the fluoroscope and lipiodol introduced. The patient is urged

not to cough until the examination is complete. Considerable information is obtained as the filling of the bronchi is observed. No lipiodol injection of the bronchial tubes is complete for diagnosis unless fluoroscopy has been used in conjunction with the injection. By this method, the patient can be so controlled as to make a bilateral injection of lipiodol possible at one time. It is not sufficient to make anteroposterior exposures alone, but it is of decided importance that oblique exposures be also made. These oblique exposures will often reveal pathology in the retrocardiac area which otherwise would be overlooked. The after care of the patient is extremely simple. These patients are allowed to return home after *x*-ray studies have been made, and are instructed to assume a position to favor pulmonary drainage for about fifteen minutes.

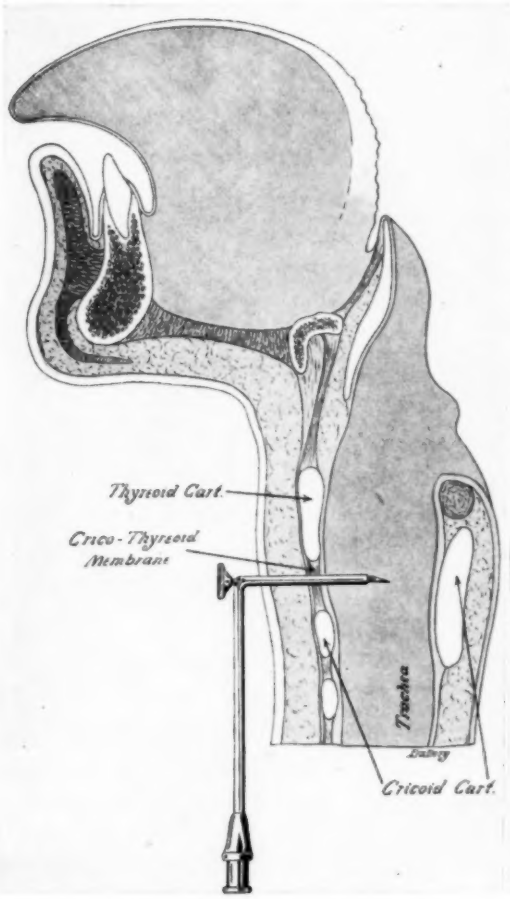

Fig. 1.

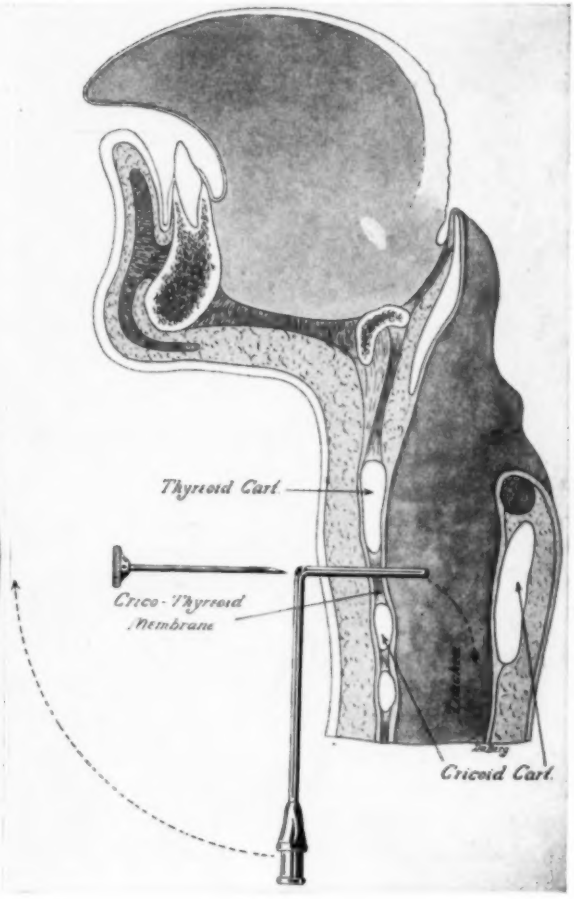

Fig. 2.

Lipiodol is of decided aid in the diagnosis and closer study of the following conditions: bronchiectasis, pulmonary abscess, pulmonary tuberculosis, emphysema, bronchial asthma, pulmonary fistulae and lesions of the pleura. With the use of lipiodol, a classification of pulmonary abscess and bronchiectasis is possible upon which treatment and prognosis may be based. It is the only positive method of diagnosing bronchiectasis. It has enabled us to distinguish bronchiectasis from cavities due to pulmonary tuberculosis. It has also been of inestimable value in determining the effectiveness of pneumothorax and thoracoplasty.

The chief diagnostic value of lipiodol is seen in suppurating conditions, such as lung abscess, bronchiectasis and empyema. We recognize four types of images seen in bronchial pathology: moniliform, ampul-

lary or cylindrical dilatations, stricture and occlusion. The moniliform images are a series of bead-like dilatations, often in

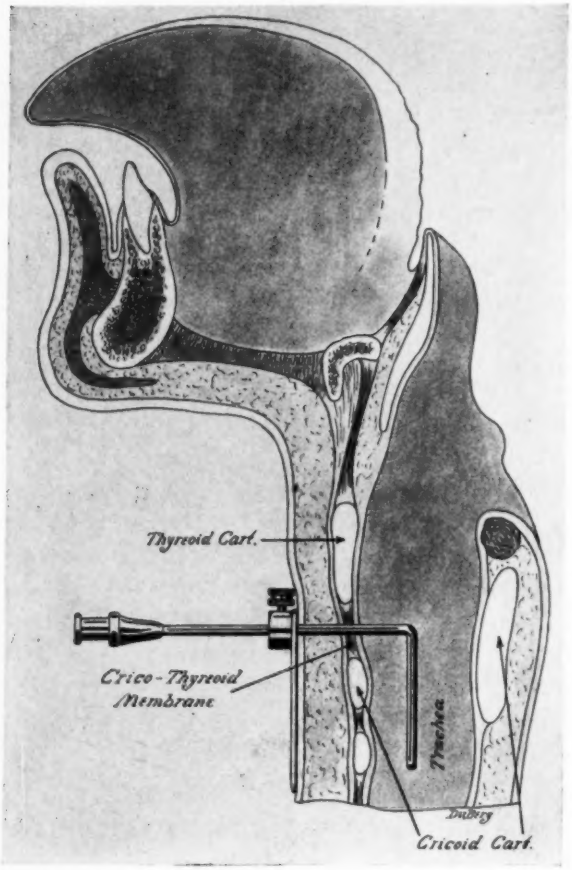

Fig. 3.

straight alignment seen on a medium-sized bronchus. It is often found near the base of the lung. Ampullary dilatations often resemble small cavities so closely as to be confusing at times. The cylindrical dilatations are perhaps the most common of all types and are particularly to be seen in the retrocardiac portion of the lung. Often these cylindrical dilatations become superimposed upon one another in such a way as to resemble a large cavity. Several roentgen exposures in different planes will reveal the true condition, or better still the observation of the filling of the bronchi under fluoroscopy. Bronchial strictures are revealed by lipiodol as linear shadows, very thin like two lines which are rarely in alignment. These shadows are usually noticed where a therapeutic compression exists and in the vicinity of neoplasms and old cavities. Occlusions of bronchi are shown by shadows stopping abruptly at

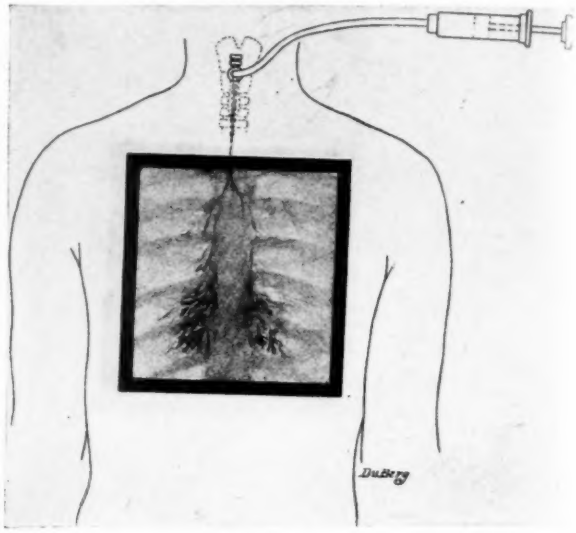

Fig. 4.

the site of the obstruction. Not infrequently bronchiectasis and abscess are associated. This association undoubtedly explains the failure of a cure after surgical or bronchoscopic drainage of an abscess cavity. H. C. Ballon has described a bottle-neck type of abscess which cannot be demonstrated by *x*-ray or contrast media because the sputum drainage merely represents an overflow from an already filled cavity. The difficulty, therefore, of filling such a cavity with lipiodol except by suction and direct filling through a bronchoscope makes its detection often uncertain. In most instances lipiodol reveals an abscess by a negative shadow, because the lipiodol enters the surrounding tissue and avoids the cavity.

The use of lipiodol in pulmonary tuberculosis has been productive of considerable discussion as to its advisability. However, experience has now more than justified its use in cases which are definitely of the fibrotic type. It is particularly of great aid in those patients who have been subjected to thoracoplasty to help in revealing cavities or bronchiectases which were not fully collapsed, permitting further procedures to close these areas of suppuration. Jacobaeus

has used lipiodol to determine the extent of lung tissue in adhesions before cauterizing. Exudative and any active process

week. During this time he had no further asthmatic attacks. Bronchography showed normal arrangement of the bronchial tree,

Fig. 5.

Fig. 6.

ingrafted upon a fibrotic lesion distinctly contraindicate the use of lipiodol. From a personal experience with three tuberculosis cases, lipiodol has been found definitely to aggravate an exudative lesion, increase the expectoration and cause a rise in temperature and pulse rate. Lipiodol should not be used in tuberculous cases except for a very definite reason. Its routine use here is to be condemned. Lipiodol should not be used in cases of recent hemoptysis.

The ever-increasing use of lipiodol for diagnosis and the importance of collapse therapy in pulmonary lesions have stressed the complications which may follow lipiodol instillations into the lung. We have injected lipiodol in the case of bronchial asthma in a twelve-year-old boy. This patient was subject to an average of three attacks a week. Each attack, lasting about two hours, was relieved quite promptly by adrenalin. On being given 10 c.c. of lipiodol in each lung, the boy had no immediate reaction, but half an hour later he suddenly became very dyspneic and had an asthmatic attack. This attack, his mother stated, did not seem as severe as other attacks. Following this attack, the patient developed fever and cough lasting nearly a

except for an occasional slight cylindrical dilatation in a few of the more terminal bronchi. Pinchin and Morlock report a case of acute massive collapse with recovery following almost immediately the introduction of lipiodol into the lung. Jacobaeus, Selander and Westermark, in their paper on acute massive collapse of the lung, record four such cases occurring about fifteen minutes after the injection.

What happens to the lipiodol in the lung? Experimental studies by A. L. Brown have shown that a mononuclear infiltration of phagocytic type is excited in healthy alveoli. These phagocytes following lymphatic channels are the important agents in the removal of lipiodol. At least during the first four weeks there is no evidence of incapsulation of the oil remaining in the alveoli. Fieslinger and Lemaire in reporting the results of a post-mortem examination in a tuberculous patient found that lipiodol, when injected intrapleurally, did not penetrate tuberculous tissue, but that cells filled with lipiodol entered the infiltrated areas. It is their suggestion that possibly this absorption favors parenchymatous fibrosis. They noted, however, that this fibrosis shows more congestion than is

usually seen in the fibrosis of tuberculosis. It apparently does not increase the fibrosis of the tuberculous lesions themselves, but only a neighboring sclerosis. In an area of active tuberculosis lipiodol may favor diffusion of the lesion.

One case of ours, a patient with unilateral bronchiectasis had had four injections of lipiodol for diagnosis over a period of five weeks. This patient was finally subjected to a lower paravertebral thoracoplasty in one stage. This patient developed pneumonia and died three weeks after operation. At autopsy, an organizing pneumonia was found on the side operated upon, which showed excellent compression. Special studies were made to determine the fate of the lipiodol previously injected. No lipiodol was found in the alveoli but in the lymphatics of the lower lobe and in the hilus nodes, lipiodol could be readily detected in large mononuclear cells of the phagocytic type. Lipiodol may disappear radiographically within three weeks or may last as long as eight months.

From our experience the indications for the use of lipiodol in the diagnosis of pulmonary lesions are as follows:

1. In pulmonary suppuration exclusive of tuberculosis.
2. In pleural suppuration of the chronic type especially complicated with fistula.
3. In lung abscesses as an aid in localization and in determining the extent of the associated bronchiectasis.
4. To determine the efficiency of collapse therapy in non-tuberculous suppuration.
5. In neoplasms of the lung and mediastinum.
6. In tuberculosis, the indications are more sharply defined. Lipiodol should only be used in tuberculous cases where particular and definite information is desired and where other methods will not suffice. Its usefulness to determine the efficiency of collapse therapy in tuberculosis need only be mentioned to be appreciated. The lesion, of course, should be definitely fibrotic.

The contraindications are as follows:

1. Active pulmonary tuberculosis.
2. Recent hemoptysis.
3. Decreased vital capacity.
4. Most cases of asthma.
5. Cachectic and debilitated patients.
6. Age is not necessarily a contraindication.

CONCLUSIONS

Bronchography is an essential feature of any pulmonary diagnosis. Its administration by puncture of the cricothyroid membrane by this specially devised cannula is both certain and dependable. The procedure is entirely safe.

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EPIPHRENAL DIVERTICULUM OF THE ESOPHAGUS

WITH CASE REPORT

EMIL GRANET, M.D.

NEW YORK CITY

DIVERTICULA of the esophagus are best and most simply classified by their anatomical position as pharyngo-esophageal, epibronchial and epiphrenal diverticula.

Pharyngo-esophageal diverticula arise in most cases from the posterior wall of the pharynx at the pharyngeal dimple, which is located at the junction of the transverse and oblique fibers of the cricopharyngeous muscle. This type is seen most frequently; is classified as pulsion diverticulum because of its etiology and can be treated surgically.

The epibronchial diverticula are true esophageal diverticula. They are situated in the midportion of the esophagus and are usually traction diverticula. They occur most often after inflammatory lesions of the adjoining tracheobronchial lymph nodes. Resultant fibrous adhesions of the healed glands to the adjacent esophagus, combined with the intra-esophageal pressure of food and air on the wall of the tube during deglutition explain the etiology.

Epiphrenal diverticula are also true esophageal diverticula. They occur in the lower third of the esophagus just proximal to the diaphragm. As primary conditions, epiphrenal diverticula occur infrequently. A careful review of the available literature resulted in finding only 49 cases of this condition. Of these, on analysis only 31 cases were accepted as definitely proved cases of epiphrenal diverticulum. These were either postmortem reports fully described, or were clinical cases with undoubtable roentgenographic evidence.

The first reference to this condition occurs in a record of a case by DeGuise in 1833. Oekonomides in 1882 reported 2 cases found at postmortem section. Virchow, Tetens, Stark, Hausman and Borsche reported other cases found accidentally at postmortem. Up to 1899, Mintz, Reichman, Kelling and others reported clinical cases which they thought were epiphrenal diverticulum. These cases had symptoms of esophageal obstruction. The diagnosis in each case was presumably established by inconclusive test with tubes and bougies, and by the auscultation of swallowing sounds.

Reitzenstien in 1898 was the first to use the roentgen ray to assist clinical methods in making a diagnosis of epiphrenal diverticulum. He was followed directly by Jung and Zweig. The true value of the roentgen ray in the diagnosis of this condition was not appreciated at this time. It was not until 1909 that Kaufmann and Keinbock

Year	Reported by	Cases
Found Postmortem:		
	Hausman	1
	Stark	1
	Tetens	1
1882	Oekonomides	2
1900	Borsche	1
Clinical and Roentgenographic Diagnosis:		
1898	Reitzenstien	1
1900	Jung	1
1901	Zweig	1
Roentgenographic Diagnosis:		
1909	Kaufman and Keinboch	1
1916	Stierlein	2
1920	Carman	1
1921	Freund	3
1921	Dachtler	1
1922	Bensaude, etc	2
1923	Haenisch	1
1923	Dessecker	1
1924	Kremer	1
1925	Hurst	2
1925	Vogl	1
1925	Guisez	1
1928	Smith	2
1928	Simon	1
1929	Fitzgibbon	1
1931	Quartero	1

reported the first case of epiphrenal diverticulum found roentgenographically.

The proven cases of epiphrenal diverticulum reported to date as shown on p. 259.

The etiology of pulsion diverticula in the lower thorax is not known. Carman[1] states that the majority are congenital. Important factors in the development and enlargement of these pulsion diverticula are the following: (a) the negative thoracic pressure, (b) the positive intra-esophageal pressure during deglutition, (c) the anatomy of the lower esophagus.

Dessecker[2] points out that in order to reach the cardia of the stomach, the esophagus turns laterally to the left in its lower third. This turn causes food boli, when descending to impinge upon the wall of the esophagus at the lower right corner of this natural curve. The eventual result is a pouching of the wall at this point. Enlargement of the diverticulum usually takes place downward and toward the right. This is so because the left anterior is obstructed by the heart and pericardium; posterior enlargement is improbable because of the presence of the spine. That this reasoning is probably correct is shown by the fact that of 28 cases reported, only 3 were left sided.

The etiology of traction diverticulum is determined by previous pathology ia this region.

Symptoms due to epiphrenal diverticuln depend upon the size, location and complications present. In many of the cases there are no direct symptoms, as evidenced in the case report which follows. In others, symptoms are caused by existing complications such as carcinoma or cardiospasm.

Symptoms develop insidiously. Where the diverticulum attains a large size, dysphagia, substernal pain and pressure may occur. Emaciation results as symptoms increase in severity. Stasis and putrefaction of food cause inflammatory changes in the diverticulum. Perforation of the viscus might occur with resulting mediastinitis and death.

The following analysis of the 31 reported cases will serve to illustrate the aforementioned points.

Total Cases—31

Found postmortem	6
Clinical and roentgenographic diagnosis	3
Roentgenographic diagnosis	22

Sex

Male	20
Female	9
Unreported	2

Location Reported—29

Right sided	23	(Right Anterior	10
		Right Lateral	8
		Right Posterior	4
		Right	2)
Left sided	3	(Left Anterior	1
		Left Posterior	1
		Left	1)
Anterior	2		

Age

Youngest	15	Oldest	83

Direct Symptoms	17
No Symptoms	9
Not Reported	6

Complications

Associated with carcinoma	2
Associated with cardiospasm	6
Associated with gastric ulcer	1
Associated with diaphragmatic hernia of the stomach	1

The roentgen ray and contrast meals have simplified the diagnosis of epiphrenal diverticulum and supplanted former inaccurate diagnostic methods. In doubtful cases, esophagoscopy should be employed.

During routine examinations of the gastrointestinal tract for other conditions, thoracic diverticula are found. The following case is typical:

REPORT OF CASE

M. C., a retired merchant, aged sixty-four, was first examined September 20, 1927. He had had a prostatectomy in 1920 and for the past four years dysuria and frequent tenesmus. During the past year the patient had lost 14 pounds in weight, had anorexia, occasional left-sided abdominal pain associated with increasing constipation and increasing asthenia.

[1] Carman, R. D. The Roentgen Diagnosis of Diseases of the Alimentary Tract. Ed. 2, Phila., Saunders, 1920, p. 72.

[2] Dessecker, C. Das Epiphrenale Pulsionsdivertikel der Speiseröhre. *Arch. f. klin. Chir.*, 128: 236–247, 1924.

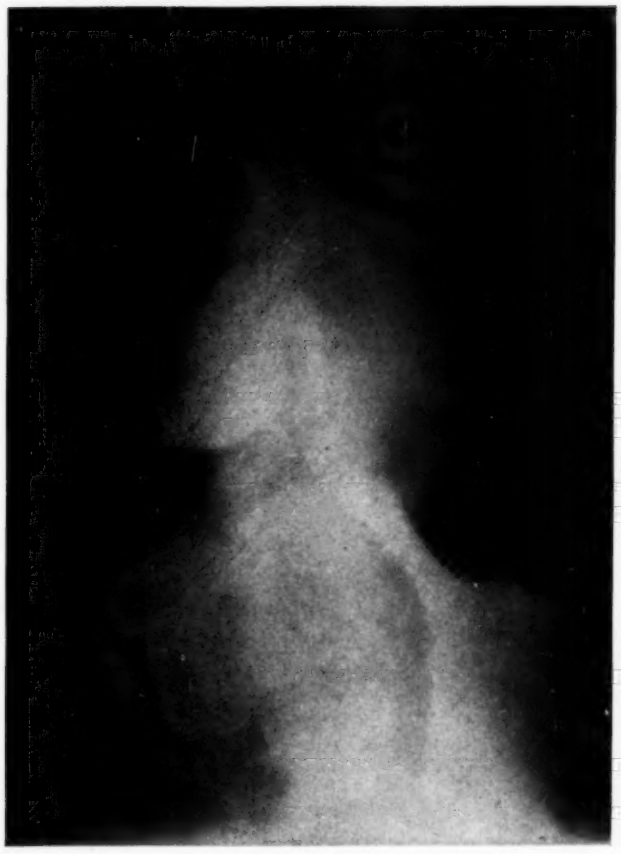

FIG. 1. Diverticulum, food residue present, patient erect.

FIG. 2. Diverticulum with patient supine.

FIG. 3. Twenty-four hour residue in diverticulum. Patient erect.

Physical examination revealed no positive findings to account for the constitutional symptoms. The patient was referred for a

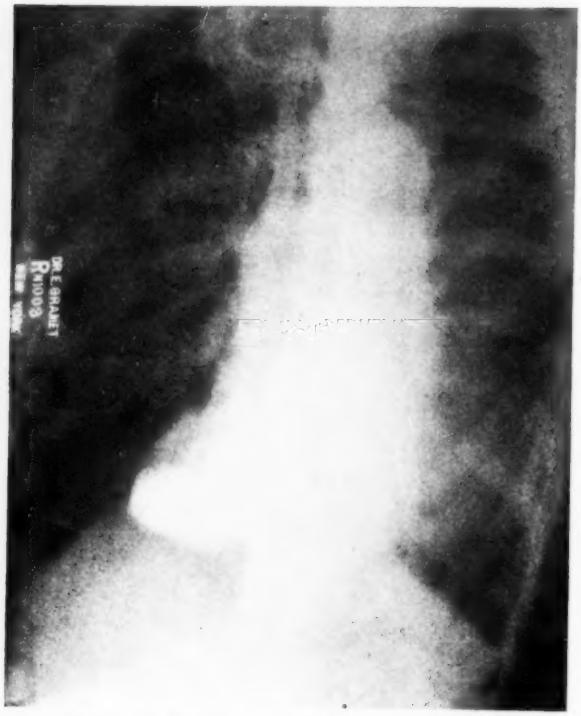

Fig. 4. Diverticulum four years later showing no change in roentgenograph.

gastro-intestinal series to rule out silent neoplasm.

During roentgenoscopic examination of the esophagus the contrast meal was seen to fill a large smooth-walled diverticulum to the right lateral side of the esophagus. The neck of the sac was situated 4 cm. from the diaphragmatic hiatus. The diverticulum apparently contained a food residue as there was seen a defect in the barium shadow in about the mid-portion of the pouch. The sac measured 8 cm. in width and 10 cm. in height in the right oblique position. Barium was retained in the lumen through out the period of roentgenoscopic observation. At twenty-four hours a barium residue of 50 per cent was seen in the diverticulum. There were no factors in the history which could enable us to determine the etiology. Further questioning could elicit no symptoms such as dysphagia, pressure, regurgitation, vomiting or pain at any time in the patient's past or present history.

An Ewald tube was passed into the stomach with no difficulty. The gastric chemistry was relatively normal.

The patient was again examined on November 14, 1931, more than four years after the first examination. There was no change in the appearance of the diverticulum. No esophageal or gastric symptoms had developed in this interum. The patient complained only of dysuria.

Treatment is entirely symptomatic. In mild cases occasional lavage of the sac with specially curved sounds is sufficient. In cases associated with cardiospasm the use of dilatory bougies usually alleviates the symptoms. Operation for the removal of epiphrenal diverticulum has been attempted twice. Enderlen reports a case of 1910 where operation was successfully performed by means of a left posterior pleural approach. The patient succumbed to circulatory failure on the second day. Stierlein[1] describes an operation performed on his second case in 1916. Approach was obtained by transpleural thoracotomy, and the sac was excised. This patient survived until the next day, when death occurred following leakage through the suture line. Quartero[2] reports an apparent six months cure in a man of forty with a large right-sided diverticulum causing symptoms for five years. Approach was made through a right posterior incision and the pouch was successfully removed.

SUMMARY

Thirty-one reported cases of true epiphrenal diverticulum are analyzed.

The etiological considerations of this condition are discussed.

A typical asymptomatic case is reported.

[1] Stierlein, E. Klinische Röntgendiagnostik des Verdauungskanals. Ed. 1, Wiesbaden, Bergmann, 1916, p. 37.

[2] Quartero, P. B. V. Un cas de diverticule epiphrenique de l'oesophage. *Acta Oto-Laryng.*, 15: 94–100, 1931.

AGENESIS OF THE GALL BLADDER ASSOCIATED WITH PANCREATITIS

REPORT OF A CASE*

PHILIP D. AMADON, M.D.

MONROE, MICH.

ANOMALIES of abdominal viscera confronting the surgeon may present a very perplexing problem. Especially is this true when an entire organ, thought to be the seat of pathology, is absent. It is then that a knowledge of the embryological development and physiology may explain the situation and suggest a means of treatment. A case of an unusual anomaly, absence of the gall bladder, is here reported, complicated by an uncommon pathological condition, pancreatitis. A survey of the literature and an attempt to correlate the anomaly and existing pathology is made.

It is a singular fact that some of certain closely related species of animals have a gall bladder, while others do not. Among the higher animals it is present in the cow and sheep, while it is absent in the horse, present in the goat and absent in the closely related deer, to be found in the hog and wild boar but not in the peccary of South America. Among the birds, the hawk and owl possess it, while doves do not; and among the rodents the mouse is found with the organ, the rat without.

Agenesis or congenital absence of the gall bladder occurs very infrequently in the human. Schachner in 1916 reviewed the entire literature and petitioned the leading anatomical laboratories for such cases; reporting but seven undisputed cases of its absence. He included only cases of congenital absence or agenesis, as opposed to an absence of the gall bladder due to its destruction through a pathological process. The seven reported cases did not include intrahepatic anomalies, left-sided gall bladders, transposition of viscera or floating gall bladder. As in anomalies elsewhere in the body, anomalies of the gall bladder frequently do not occur singly. In Schachner's group the following anomalies occurred in addition to an absent gall bladder:

Case II. The quadrate lobe of the liver was wanting.

Case III. The fossa for the gall bladder was replaced by a small fissure.

Case VI. A deep furrow was present on the under surface of the liver in the position the gall bladder should occupy.

Case VII. The lobus quadratus was absent.

The development and embryology of the biliary tract is naturally involved in the embryology of the liver. The liver like the pancreas is developed from the duodenal portion of the gut as an outgrowth or evagination from the entoderm. The cephalic part of the evagination is solid and is destined to become the liver proper, being designated as the pars hepatica. In human embryos of 3.2 mm. the primitive pars hepatica appears as a wide hollow pouch, composed of hypoblast cells, growing between the two layers of the ventral mesogastrium, which membrane extends between the ventral border of the primitive stomach and the abdominal wall. Beginning at both the cephalic and caudal ends, the evagination as a whole becomes constricted from the gut until in 8 mm. embryos its only connection with the latter is the anlage of the ductus choledochus. The pars

hepatica enlarges and remains attached to the ductus choledochus by a short cord of cells, the anlage of the hepatic duct. At an early stage the gall bladder is derived from the main duct, close to the intestine, as the pars cystica or cystic diverticulum. Later on the common duct grows in length, making the liver more and more a gross anatomical organ distinct from the intestine. The pars cystica lengthens and its distal portion becomes dilated to form the gall bladder.

In absence of the gall bladder in a species a single large hepatoenteric tube is found, or instead a number of smaller ducts which enter the intestine successively.

As regards the known physiology of the biliary tract, Aschoff states that in the light of the work of the past few years the gall bladder is to be looked upon as a regulatory mechanism, shunted into a system of tubes which even in an already well-filled state can collect by concentration all the bile secreted between two periods of digestion, an amount which could not find a place in the bile passages. McMaster's ligation experiments on rats in which the gall bladder is normally absent revealed the absolute inability of the ducts to concentrate the bile even though enormous dilatation took place. Similar ligations in the mouse, possessing a gall bladder, demonstrated marked concentration of the gall bladder bile. McMaster concluded that the function of the gall bladder cannot be assumed by the ducts when the gall bladder is normally absent. It must be observed however that rat bile on leaving the liver is eight times more concentrated than mouse bile. Rous and McMaster showed that gall-bladder bile may reach a concentration ten times that of hepatic bile.

Gall-bladder bile is more viscid in character due to the presence of a nucleoprotein.

The bile pressure according to Heidenhein is about 200 mm. of water.

Embryologically the pancreas develops from the entoderm of the gut in the region of the duodenum close to the liver evagination. The gland develops primarily from two outgrowths, each of which furnishes an excretory duct system. The union of the two pancreatic outgrowths and the formation of the main duct of Wirsung which empties with the common bile duct into the duodenum at the ampulla of Vater is considered normal embryological development.

A careful search of the literature fails to reveal a reported case of pancreatitis in association with an absent gall bladder. The following statistics however show the frequency with which biliary tract and pancreatic pathology occur together. In 1907 Egdahl reported 105 cases of acute pancreatitis, 44 of which were associated with cholelithiasis. In 1919 W. J. Mayo stated that 90 per cent of patients having acute and chronic pancreatitis had been operated upon for an infected gall bladder. In 1921 Deaver reported 79 patients with chronic pancreatitis, 72 or 91 per cent with evidence of biliary infection. Judd, 1921, found pancreatitis present in 347 or 26.8 per cent of 1290 cases in which operations were performed for disease of the biliary tract. In 1923 Whipple reported a series of 230 consecutive unselected cases of disease of the biliary tract; 40 of these showed definite pancreatic lesions.

The writer recently encountered such a case in a woman of thirty years with a long history resembling that of gall-bladder pathology and stones. Operation was performed at which time multiple areas of fat necrosis were found in the upper abdominal cavity and the pancreatic neck was enlarged and thickened. Exploration of the upper abdomen failed to reveal a gall bladder. The upper peritoneal cavity was drained and the postoperative convalescence was very stormy, the patient passing through eighteen days of severe asthenia. On the third postoperative day a left parotitis developed which subsided on the ninth day. A persistent pancreatic fistula remained in spite of general improvement. Several months later on surgical closure of the pancreatic fistula the gall bladder, containing stones, was found in the lower right abdomen and removed.

That a definite relationship exists between the biliary system and pancreatic pathology is borne out by recent experimental work. The action played by bile in producing an acute pancreatitis was first demonstrated by Claude Bernard in 1856. Experiments carried out by Flexner, Carnot, Opie and others showed that pancreatitis could be produced by injecting bile, bile salts and other substances into the pancreatic duct. Archibald has shown that all varieties of pancreatic inflammation found in the human can be reproduced experimentally by the injection of various kinds of bile into the pancreatic duct. The injection of aseptic bile mixed with gall-bladder mucus produces a very mild swelling of the organ. Bile unmixed with gall-bladder mucus produces a more severe reaction and the injection of infected bile produces a very acute pancreatitis which is apt to be primarily necrotic. It was found possible in cats to produce a pancreatitis at will by injecting into the gall bladder, bile which had been altered in the foregoing ways. Archibald believes that an injection of bile into the pancreas not infrequently occurs; but when the bile is normal and contains its due amount of mucus, no harm is done to the pancreatic cell and no clinical symptoms are evoked. On the other hand, when by reason of occlusion of the cystic duct, the bile remains unmixed with mucus derived from the gall-bladder epithelium, then, as Flexner showed, the effect of the bile salts upon the pancreatic cell is more pronounced, and there occurs a mild aseptic inflammatory reaction, which would be sufficient to cause a moderate degree of pain. It was found that the worst cases of hemorrhagic pancreatitis followed the injection of the pancreatic duct with a small amount of bile infected by Bacillus coli.

In 1899 Lancereaux suggested that gallstones lodged in the ampulla of Vater might cause pancreatitis by obstructing the pancreatic duct and Opie in 1901 reported a case in which necropsy revealed a gallstone lodged in the ampulla of Vater. The stone obstructed the flow of bile into the duodenum but did not prevent it from passing into the pancreatic duct.

Nordman after ligating the ampulla noted a distention of the pancreatic ducts with bile but no necrosis.

Archibald believes that a spastic contraction of the sphincter of Oddi may explain the retrojection in cases in which pathology is found in the region of the stomach or duodenum, the muscle being held in temporary spasm by the action of the acid duodenal contents. The muscle at the sphincter of Oddi was found to be able to resist a pressure several times higher than that under which bile is secreted in the liver; it could be put into spasm by the application of weak hydrochloric acid to the duodenal mucosa; and its resistance was such as to force injection fluid, introduced into the gall bladder, into the finest ramifications of the pancreatic duct. Mann found that bile passed into the pancreatic duct in most instances at 500 mm. pressure of water. Deep respiratory movements and vomiting elevated the pressure so that is reached as high as 1000 mm.

Whipple was the first to describe the syndrome, pancreatic asthenia, as a postoperative complication of biliary tract or pancreatic surgery and to classify it as an entity. A summary of his description of the condition and its course is as follows: Extreme asthenia, anorexia, apathy, nausea and vomiting and rapid loss of weight. The asthenia appears at intervals after operation, varying from the second to the ninth day and has lasted for periods varying from two to thirty days. It is manifested objectively by muscular relaxation and the mask-like expression, the feeble drawling voice and the weakened grip.

The occurrence of parotitis has been frequently reported in the literature following pancreatic operations and is noteworthy in view of the fact that inflammation of the pancreas may occur after mumps.

The following is the detailed report of a case of agenesis of the gall bladder in association with pancreatitis:

Case History. Mr. D. K., aged fifty-one years, laborer. Admitted to Mercy Hospital June 22, 1931.

History revealed infrequent attacks of "indigestion" and slight abdominal pain as long as the patient could remember. Six months previous to admission there was a severe attack of pain in the upper abdomen, beneath the right rib margin and right scapula, accompanied by nausea and vomiting. The pain lasted several hours and was followed by soreness in the upper abdomen, the entire attack lasting about two weeks. There was no jaundice, constipation or stool change although vomiting occurred frequently and there was much flatus. Two weeks previous to admission a similar attack occurred although more severe. No fever, jaundice, stool or urine change were noted. Vomiting was persistent and the patient felt tired and weak.

Physical examination revealed an obese male of fifty-one years showing evidence of acute illness. The examination was essentially negative except for moderate tenderness across the entire upper abdomen, more marked beneath the right costal margin. No masses were palpable. There was voluntary muscle spasm but no rigidity. Temperature 97°F., pulse 70, respirations 18. Urinalysis: negative. Blood: Hb. 95 per cent, R.B.C. 5,480,000, W.B.C. 9600. Cholecystograms did not reveal a gall bladder.

A preoperative diagnosis of chronic cholecystitis and cholelithiasis was made and the patient prepared for operation. On exploration of the abdomen no gall bladder could be found. The liver was easily rotated and the under surface of both lobes easily examined. No quadrate lobe was present. The under surface of both lobes was entirely free from any structures resembling a mesentery of a floating gall bladder. The round ligament was carefully examined but no gall bladder found in its folds. No cystic duct could be identified. The common duct was slightly dilated but in normal position and relation to the vessels. The foramen of Winslow was open and palpation of the pancreas disclosed a firm, irregular induration extending from the region of the neck toward the body of the organ. There was no evidence of fat necrosis. No biopsy was made. Exploration was otherwise negative for pathology. The wound was closed around a large drain placed near the foramen of Winslow.

Following a stormy postoperative first day at which time the patient became cyanotic and had marked respiratory difficulties, the convalescence was uncomplicated. The wound drained but moderately and following removal of the drain on the fourth day, closed rapidly. He was discharged home on the fourteenth day and has been seen frequently since and to date is symptomless except for an infrequent transitory pain in the upper abdomen.

Final diagnosis: Agenesis of gall bladder. Chronic pancreatitis.

It is interesting to note that in this case other anomalies of the biliary tract existed in addition to the absent gall bladder. The quadrate lobe of the liver was wanting.

DEDUCTIONS

Congenital absence of the gall bladder disturbs the pressure balance normally present in the biliary system. The gall bladder acts to relieve undue pressure changes in the biliary system which may be raised from a normal secreting pressure of 200 to 500 to 1000 mm. by deep respiratory movements or vomiting. In the absence of the gall bladder the duct system does not or is unable to dilate sufficiently to compensate for increased pressure changes with a resulting retrojection of bile into the pancreatic duct which is possible under 500 mm. pressure.

In congenital absence of the gall bladder a definite protective substance is lost to the bile. Archibald's and Flexner's experiments demonstrated that bile mixed with gall bladder mucus produced no changes in the pancreatic cells, whereas bile unmixed with the same mucus produced destructive changes. McMaster proved that in animals normally lacking a gall bladder, the ducts were unable to concentrate or alter the liver bile and thus could not assume the function of the gall bladder. It can therefore be assumed that bile secreted by a patient in whom the gall bladder is congenitally absent

will produce destructive pancreatic changes if it gains access to the duct. It cannot be stated with certainty at the present time, because of the limited number of such cases, whether the liver possesses the power of concentrating the bile in the absence of the gall bladder, as occurs in animals normally without it. Suffice it to state that although a moderate dilatation of the hepatic duct was present it was not of the degree seen following cholecystectomy. Bile to which the protective mucus of the gall bladder is lost may thus be retrojected into the pancreatic duct due to the elevated pressure within the common duct because of the gall bladder's absence, producing varying degrees of pancreatitis.

SUMMARY

1. Seven cases of absence of the gall bladder were reported in the literature.

2. A case of agenesis of the gall bladder with complicating pancreatitis is reported in this paper.

3. Absence of the gall bladder may produce pancreatic changes through increased bile pressure and lack of protective mucus in the bile.

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CONCLUSION OF DR. BANDLER'S ARTICLE*

Those who are especially interested in the chemistry and the chemical experimentation with diothane should consult Dr. Rider's several comprehensive papers.[1] At the present time we are engaged in an experimental study of the effects and anesthetic qualities of diothane in spinal, sacral, caudal and paravertebral administrations.

CONCLUSIONS

1. Diothane is a safe and efficient anesthetic agent for local urethrovesical application.

2. Diothane is apparently non-toxic when administered to the urethra and bladder.

3. Diothane causes a post-instrumental analgesia "which appears to be unique to this compound among the local anesthetics now available."

4. To procure adequate anesthesia, it is advisable to allow diothane to remain in situ for ten minutes before instrumentation.

5. Examinations with diothane anesthesia may be frequently repeated without any evidences of toxicity.

[1] Rider, T. H. *J. Am. Chem. Soc.*, 42: 2212; 2583, 1930. *J. Pharmacol. & Exper. Therap.*, 39: 329; 457, 1930. *J. Pharmacol. & Exper. Therap.*, 1932, in press.

* Continued from p. 251.

TUMORS OF THE DUODENUM*

EDWARD L. KELLOGG, M.D., AND WILLIAM A. KELLOGG, M.D.

NEW YORK CITY

BENIGN and malignant growths of the duodenum occur with sufficient frequency to justify consideration.

BENIGN TUMORS

The following case report is instructive:

Male, aged sixty-nine, for four years had moderate attacks of indigestion. Ultimately there was a sudden attack of severe cramp-like pain which recurred frequently for twenty-four hours. It started below the navel and extended across the abdomen. Later there was observed a gradual loss of weight and progressive anemia.

When admitted to the hospital he was prostrated. Roentgen-ray examination showed dilatation of the duodenum and of the upper jejunum. The stools contained blood.

Blood examination showed erythrocytes 1,370,000; hemoglobin 33 per cent; leucocytes 6500.

Laparotomy was performed after several transfusions. The upper jejunum was distended, dark, and contained an oval mass which was pushed upward until it presented at the pylorus where it was excised through an incision crossing the pylorus at right angles.

The patient recovered.

The growth was a pedunculated adenoma, attached to the posterior duodenal wall. It was apparent that intussusception of the duodenum and pyloric end of the stomach into the jejunum had caused partial obstruction.

Benign tumors are more common than malignant growths. They may be of congenital origin, although usually observed in adults.

Lipomata, angiomata, fibromata, adenomata, myomata, congenital cysts and pancreatic tissue tumors are described. Of 119 benign tumors of the digestive tract collected by King, 4.2 per cent were in the duodenum.

They may be subserous, submucous or internal (pedunculated) and attain considerable size.

Lipomata are of rather frequent occurrence. Lymphangiomata are rare but several cases of hemangiomata have been described.

Adenomata are usually internal and pedunculated, but are occasionally submucous, originating in Brunner's glands. Myomata originate in the muscular layer and extend both externally and internally.

Cysts developing on the basis of intestinal derivatives are usually single but occasionally are multiple. Pancreatic tissue tumors are pancreatic rests that have undergone inflammatory changes. They are attributed to penetration of the wall of the intestine by branches from embryonic growths which become separated and acquire new ducts. The dorsal growths are carried upward to form gastric and upper duodenal nodules, while those from the ventral buds are carried downward to form masses in the lower duodenum, jejunum, and ileum. By weakening the muscle layer they may lead to diverticulum formation and may be the starting point of malignant growths.

Benign tumors may be latent, but usually cause vague digestive distress or more definite symptoms, nausea, vomiting, epigastric distress and tenderness.

External tumors are most frequently latent but they may obstruct the duodenum, pylorus, or bile ducts.

The most common clinical symptoms are hemorrhage and anemia. The latter is often profound and may be the only symptom. It occurs with and without ulceration of the tumor and may cause sudden death.

* Read before the Graduate Fortnight, New York Academy of Medicine, Oct. 20, 1932.

Tumors narrowing the lumen of the gut cause partial obstruction with dilatation of the stomach and vomiting of gastric and duodenal secretions.

Intussusception of the stomach and duodenum is occasionally reported.

As observed in adults, intestinal intussusception is due to a benign pedunculated tumor in more than 40 per cent of the cases. By diminishing the lumen of the bowel, and causing hyperperistalsis above, it predisposes to the onset of invagination which is further favored by traction exerted by the pedicle. Malignant tumors apparently do not cause invagination.

Intussusception causes obstructive symptoms with vomiting of large quantities of bile or coffee-ground material of offensive odor, and severe pain which may be referred to the epigastrium or umbilicus.

The diagnosis of benign tumors is occasionally made with the aid of the *x*-ray, which shows an arrest of the barium column forming a regular concave line and moulding a convex light zone.

The treatment is surgical.

MALIGNANCY

The tradition that the duodenum is immune to malignancy is only approximately true and it is wise to stress the fact that the condition is not unique, since both carcinomata and sarcomata occur. The percentage of duodenal malignancy based upon 151,784 deaths from all causes was 0.0329 per cent.

Seven thousand and five cases of malignancy of the alimentary tract occurred in the following order: Stomach 4288, rectum 1204, esophagus 1011, large intestine 482, small intestine twenty. (Heimann's statistics.)

Of one hundred twenty-four cases of malignancy of the small intestine, reported by other writers, 57 were in the duodenum. It is evident that in proportion to its length, the duodenum is more liable to cancer than the remainder of the small intestine. Such growths are usually primary. The comparative freedom of the duodenum from involvement in gastric cancer offers a contrast to the frequent involvement of the esophagus.

This may be due in part to the imperfect continuity of the submucosa and muscularis at the pylorus but the deep lymphatics of the pylorus, by pursuing a course away from the duodenum towards the cardia or pancreas, tend to direct the spread of the disease away from the duodenum. There is, however, a lymphatic connection between the mucosal networks and it is probable that the occasional spread of gastric cancer to the duodenum and vice versa follows this route.

CARCINOMA

Carcinoma of the duodenum is most frequent among men. The average age is fifty-two years, ranging from seventeen to eighty in the collected cases. Mayo believes that primary carcinoma of the small intestine is usually engrafted on a polyp, but development on an ulcer base is probably the most frequent cause when the first portion of the duodenum is involved (30 cases). The location in the vicinity of the pylorus agrees with the usual site of ulcer. It has been suggested that the starting point may be a pancreatic rest or Brunner's glands, but proof is lacking. Gallstones are only occasionally associated. Secondary growths of the duodenum originate in the cecum, colon, liver, pancreas, gall bladder, and stomach.

The majority of malignant growths occur in the second portion probably because of its communication with the bile and pancreatic ducts. They may be of the scirrhous, medullary or colloid type. Necrotic changes, ulceration, and perforation occur, the latter with the formation of localized abscess rather than general peritonitis. Metastases are infrequent or late.

Tetany and fatal hemorrhage are also described.

Adenocarcinoma occurs as an annular constricting ring, or funnel shaped in-

filtration; spheroidal-celled carcinoma is more apt to project into the lumen, to ulcerate and to obstruct the biliary papilla.

Symptoms vary with the relation of the growth to the ampulla of Vater.

Supra-ampullary carcinoma gives a clinical picture of pyloric obstruction. Ulceration and peritoneal involvement with pain and hemorrhage occur as complications. Portal obstruction with ascites develops as the disease progresses.

Juxta-ampullary carcinoma is observed in 66 per cent of the cases and three-fourths of these are limited to the papilla.

Carcinoma of the papilla is usually a soft growth which readily ulcerates so that jaundice may be slight at first, or may appear in an intense form, possibly preceded by chills and pyrexia. The jaundice may be intermittent because of variations in turgescence or vascularization of the neoplasm; or ulceration may cause sufficient destruction to temporarily relieve the obstruction, occasionally leading to complete disappearance of jaundice. Pain occurs in 50 per cent of the cases and is referred to the epigastrium or right hypochondrium. When colicky in character stones are usually found, although this may be due to distension of the gall bladder. Other symptoms described are a distaste for fats, thirst, nausea, and vomiting of large quantities of foul-smelling fluid, fever, hemorrhage, ascites. The liver is enlarged and the gall bladder may be palpable.

An important feature is the rapidity with which the disease progresses to a fatal termination. In 50 per cent of the cases the duration of life is six months or less.

Death is due to interference with the flow of bile causing biliary toxemia or other complications. This is important surgically. A phenomenon occasionally observed at operation consists of a dilated gall bladder and common duct, containing clear mucilaginous fluid. This is due to retained secretion of the mucosa of the gall bladder and ducts so that pressure in the biliary system is increased and bile is forced back into the liver. That the liver cells have not ceased to function is shown by the appearance of bile shortly after the pressure is relieved. This is worthy of note since it may be erroneously attributed to occlusion of the cystic duct.

Malignancy in this region has not usually been recognized until operation or autopsy. When an enlarged gall bladder can be palpated and there is persistent jaundice, loss of weight and acholic stools, the evidence favors a diagnosis of malignancy at the papilla or involving the common duct (Courvoisier's law). It is not possible, however, to determine in how many cases of tumor involving the papilla these symptoms can be made out.

Infra-ampullary carcinoma is usually annular, producing partial stenosis with dilatation of the stomach, pylorus and proximal duodenum.

Added to vague digestive symptoms are attacks of vomiting. The vomitus always contains bile and the quantity often amounts to 10 or 15 pints in twenty-four hours. Emaciation, early cachexia, and toxic nephritis develop with albumen, casts and scanty urine. The growth cannot usually be palpated, but an ill-defined mass may be felt, due to enlargement of the retroperitoneal glands or to infiltration of the pancreas.

In all locations the diagnosis is uncertain. There are two sets of symptoms, one common to all cases, the other varying with the location of the growth. In the first group are cachexia, emaciation, anorexia, constipation or diarrhea, abdominal pain and dilatation of the stomach. In the second group are localizing symptoms: jaundice, enlargement of the liver, distention of the gall bladder, attacks of intestinal obstruction and vomiting of bile. Cachexia is the only symptom pathognomonic of malignancy.

Lesions of the first part may be confused with pyloric obstruction due to ulcer or external pressure. Ulcer stenosis gives an antecedent history of ulcer; the stenosis develops slowly and seldom is associated with rapid emaciation or cachexia. Cancer of the pylorus gives identical symptoms. External pressure may be due to distended gall bladder, enlarged liver, aneurysm, and

enlargement of the retroperitoneal glands.

Involvement of the second portion may suggest carcinoma of the pancreas. A growth in the head of the pancreas or limited to the ampulla is accompanied from the first with jaundice which progresses in intensity. Gastric phenomena are not particularly in evidence.

Obstruction of the third part may arise from conditions other than malignancy, as external tumors, mesenteric compression, and enlarged retroperitoneal glands.

The *x*-ray is of value in locating the obstruction and is the best means of differential diagnosis although often proving inadequate. The diagnosis of obstruction is, however, enough to indicate the necessity for surgery.

Supra-ampullary carcinoma requires resection and gastroenterostomy.

With juxta-ampullary carcinoma special problems are presented.

With few exceptions the tumors are small, being likened to a pea or cherry.

Early intervention is important because of the rapidity with which the disease progresses to a fatal termination. Operation is usually possible since obstructive jaundice occurs while the growth is small, localized, and comparatively accessible. The problem of transplanting the common duct is difficult but not insurmountable. In favorable cases cholecystoenterostomy may take the place of choledochoenterostomy.

If subjected to prompt surgical attack the condition should be curable in spite of technical difficulties. Of 20 operations studied by Outerbridge, there were 12 immediate recoveries; seven of these patients died later or were lost sight of. Of the remaining five, two were well at the end of seven months, one at ten months, one at two years and one at three years and nine months.

Infra-ampullary carcinoma may be treated by mobilizing the duodenum, resecting and making an end-to-end anastomosis, or by closure of the ends and duodenojejunostomy.

SARCOMA

Sarcoma is rare. When found it is usually primary, but may be secondary or part of a general lymphosarcomatosis.

Libman collected 54 cases of lymphosarcomata of which 15 were in the duodenum.

The ages in Libman's group ranged from the first to the seventh decades of life. Nine were under ten years of age, 9 between ten and twenty, 13 between thirty and forty, and 13 between forty and fifty. Eight were in the fifth and one each, in the sixth and seventh decades. The majority were males.

All varieties of sarcomata have been observed. The growth is usually limited to the mucosa and muscularis and tends to grow longitudinally. The early infiltration of the muscularis frequently results in dilatation instead of obstruction of the intestine. Metastases regularly occur with lymphosarcomata, less frequently with other types.

Although occasionally latent there is usually an early effect upon the general system often with few local symptoms: epigastric pain and abdominal distention are most frequently noted.

Symptoms due to compression ultimately develop: ascites, edema of legs, distention of abdominal and thoracic veins, jaundice, acholic stools, dysuria and anuria. The external lymph nodes are not usually enlarged, but are occasionally noted. Emaciation and prostration are usual features. The following symptoms may be of some diagnostic aid: the presence of a tumor of the duodenum, abdominal distention, absence of stenosis, early edema of legs and scrotum, lack of involvement of external lymph nodes. The differentiation between carcinoma and sarcoma cannot be made with certainty but a large growth in a patient under fifteen without external glandular involvement and without tenderness suggests sarcoma rather than carcinoma.

Most patients die within nine months, the range of life after diagnosis being from two weeks to one and one-half years.

There have been no recoveries. Sarcoma of the duodenum is not usually amenable to surgery but growth may at times be checked by *x*-ray and radium therapy. Coley's fluid may be considered.

ADVANCED TREATMENT IN POSTOPERATIVE ILEUS*

R. NICHOL SMITH, M.D.

LOS ANGELES, CALIF.

THE treatment of postoperative ileus occupies such a definite place in modern surgery that the closest observation is essential to keep us in contact with any new procedures that may arise.

Acute appendicitis is the most common cause of ileus. In this instance, we are referring to the functional type, not an ileus caused by mechanical interference. If we are able to make an early diagnosis of appendicitis, our treatment is greatly facilitated, as in all cases of early diagnosis, whatever the condition.

The Schilling differential blood count is a very valuable adjunct in the diagnosis and prognosis of beginning and advanced infections, especially acute infections such as appendicitis. It gives us more information and is far more accurate in most cases than the old technique. In many instances, the high white count alone is being used as an operative indication. The fallacy of this will be shown where an overwhelming infection has caused the white count to be low instead of high. The polynuclear count is always subject to many variations to which the Schilling count is not heir. We would like to emphasize its use where the leucocyte and polynuclear count is high, where there is an absence of an acute infection such as ureteral or biliary calculi and where free blood is present in the abdominal cavity, as from ruptured ectopic pregnancy. Repeated Schilling counts are essential to obtain the most beneficial information from the blood picture. An early recognition of complications and more accurate diagnosis can be made by this procedure.

If a patient lives the first few days following a peritoneal infection, death after that period is due in all probability to a toxemia caused by an ileus and not from peritonitis. To combat this serious complication we place our chief reliance on: intravenous instillation of fluids, a negative pressure apparatus and the use of bacteriophage.

The oral use of water in a sufficient amount following an abdominal operation is often disastrous. Nausea, vomiting and reverse peristalsis are generally the result.

Rectal methods are unsatisfactory for three definite reasons:

1. The inability to retain all the fluid administered in this manner gives us an inaccurate intake.

2. The limited number of fluids that can be absorbed satisfactorily.

3. The disturbance of the whole gastro-intestinal tract from reflex and other causes.

The foregoing statements preclude the use of the Murphy drip. The Harris method in some instances assists very materially in relieving gas in the lower bowel with some liquid absorption, but as a whole it is very inaccurate.

Dehydration necessitates a more efficient method of subcutaneous or intravenous instillation of the required amount of fluid to carry on a proper metabolic balance. This knowledge of the amount of intake can be estimated whether it be sodium chloride, glucose or any other indicated prescription.

There is another factor which must be guarded against: the overloading of the body tissues with fluid. This is so

* Delivered before a joint meeting of the Los Angeles County Medical Association and the Los Angeles Surgical Society, May 19, 1932.

insidiously accomplished, that a postmortem recognition can only be obviated by a twenty-four or at least a twelve hour compiling of intake and output. We believe this condition has not been given the recognition it deserves.

Ordinary gastric lavage and jejunostomy have given place to the indwelling duodenal tube connected with some form of negative pressure apparatus. We have found the Ward-Connell apparatus very satisfactory. The patient's nausea, vomiting and distention are promptly relieved and the other horrors of postoperative ileus controlled or eliminated. Morphine in all such cases is contraindicated.

We do feel, however, that emphasis should be stressed on the proper use of any negative pressure apparatus that may be used. A careless intern or nurse has not only caused a very effective apparatus to be condemned, but in some instances has caused a serious calamity.

Bacteriophage is playing such an important role in the treatment of peritonitis with its associated ileus, that we cannot overlook this intriguing phenomenon.

Our observations are that in many cases where we have had unfavorable reports, the indicated specific bacteriophage often has given place to a commercial product which, in addition to being of uncertain 'phage content is heavily charged with germicides, so that what 'phages may have been originally present have been largely inactivated. What one gets here really is a chemotherapeutic agent which can be purchased cheaper apart from the 'phage packet. We are not maintaining that commercial 'phage products may not some day become of importance, but until a standard can be provided, which commercial houses may be held to, they are likely to remain of uncertain value.

Schultz of Stanford University definitely states that the whole-hearted cooperation of the profession is essential to obtain an accurate statistical knowledge necessary to a correct understanding of the subject. Bacteriophage will not be furnished by Stanford unless the complete history and progress of all cases be furnished.

The sincerity of such men as d'Herrelle, Schultz and many others who have given this subject their undivided attention, cannot be overestimated. When one considers their work has been an endeavor to discover the underlying principles involved and make them practicable for the surgeon and internist we at least should give our acquired data and not condemn on hearsay.

Improper technique in the closure of the abdomen causes serious difficulty by allowing the escape of the bacteriophage. If a drainage tube is used as the method of instillation it generally precludes the vehicle reaching its objective whether it be a localized or a general peritoneal infection.

Our indications and technique for bacteriophage instillation in local and general peritonitis follow:

Indications: Any infection, superficial or deep, including skin, sinuses, ears, blood stream, or abdomen; in the latter group are infections following operations for ruptured gastric or duodenal ulcer, ruptured appendix, traumatic or toxic ileus, strangulated hernia, etc.

Appliances Needed:

1. 20 c.c. syringe.
2. Uretheral catheter, size 18, woven web shellacked, 14 inches long. Three or 4 inches should be cut from the large end and discarded. It then can be easily connected to the 20 c.c. syringe, and can be placed in any part of the abdomen.
3. Basin of hot sterile water, to heat the syringe and tube containing the 'phage.
4. Usual tray of surgical dressings.

Preparation Used: The 'phage made by E. W. Schultz, M.D. of Stanford University is at the present time the only reliable preparation available in the West. The 'phages obtained from commercial pharmaceutical houses have proved to be inert by the time they reach their destination. Often they have a

limited range of activity to begin with, and are too heavily treated with preservatives (merthiolate, etc.).

Type of 'Phage: Any bacteriophage that is indicated by the culture findings of the infective organisms present. In emergency abdominal cases, known to be infected (and most of them are), the mixed polyvalent anticolic bacteriophage, containing also antistaphylococcus and antistreptococcus 'phage or antiperitonitis bacteriophage, should be used during operation or as soon as possible thereafter. Culture material from the patient should be sent immediately to a laboratory where the proper cultures can be made. The laboratory should send report and cultures to Stanford University as a basis for the next shipment.

Position of Patient: Reclining, or, in abdominal work, generally a Fowler or modified Fowler position.

Dosage and Method of Application in Abdominal Cases: The 'phage should be warmed to blood heat but not higher than 38° c. before opening the ampoule. The catheter should be inserted directly into the belly through the drainage opening. It is inadvisable to try to instill 'phage through a drainage tube, as generally it does not reach its objective.

Thirty to 60 c.c. are instilled high into the abdomen to allow it to gravitate throughout the peritoneal cavity. If it is instilled into the lower abdomen, where fluid may have already collected, the 'phage is likely to be immediately expelled through the drainage opening and thus wasted. The 'phage is injected just previous to or after the last stitch has been tied with the silk catheter in place. This obviates any loss of 'phage through the abdominal wound.

This large amount, 30 to 60 c.c., is used as some degree of potency is lost, because of absorption to colloidal aggregates in the exudate, etc., previous to the actual contact of the 'phage with the organism.

Repetition: Daily or twice daily, until the general condition warrants discontinuing. The amount of the dose is regulated according to the results obtained. If the patient shows improvement in temperature, pulse, respiration and general condition, use the same dose as before. If no improvement is noted, increase the dose by 20 c.c.

With a little thought given to the administration of bacteriophage in each individual case, plus the other necessary adjuncts used in connection with the management of ileus, we have several formidable weapons to carry on our fight against this frequently fatal postoperative occurrence.

CONCLUSION OF DRS. MCCARTHY AND KRAMER'S ARTICLE*

4. That as the result of early investigation and intervention, patient welfare is most certainly conserved and a compensatory lowering of the incidence of malignancy reasonably to be anticipated.

5. That even with advanced and ineradicable cancer of the prostate, a degree of comfort and earning capacity, until quite recently unattainable, is now available.

Finally, because of the habit complex of groove thinking, prevalent in medicine, as doubtless it is elsewhere, it is most difficult to break away from the precepts and prejudices of the past. By the same token, the most alluring of practices is the nursing of hobbies. We should therefore, detach ourselves from pride of procedure or prejudice as to method, by remembering that our vocation is the salvage of human life, and the alleviation of physical distress.

For the helpful co-operation of Drs. J. Sydney Ritter and James I. Farrell, acknowledgment and appreciation is here recorded.

*Continued from p. 214.

SCHILLING DIFFERENTIAL BLOOD COUNT IN APPENDICITIS*

J. VERNON LUCK, M.D.

LOS ANGELES, CALIF.

OUR present standard classification of leucocytes was made by Ehrlich after he discovered an aniline dye for which blood cells have a pronounced affinity. The successful study of leucocytes dates from this discovery. Before this time leucocytes were thought to originate from one common blood forming system. Ehrlich and Naegeli were the first to suggest that there were at least two systems, the myelogenous and the lymphatic. That there are two such systems is now a well-established fact. Recently a third and entirely independent system has been demonstrated which forms the monocytes (the large mononuclears and transitionals). These cells are said to originate from the reticulo-endothelial system of the spleen, liver, etc. The cells from the myelogenous system or bone marrow were at first all called granulocytes and those from the lymphatic system called lymphocytes. Later Ehrlich subdivided the granulocytes into neutrophils, eosinophils, and basophils, thus originally establishing the classification that is still standard. Clinically the neutrophils are by far the most important cells in the blood picture. A study of their nuclear changes has proved of the utmost clinical significance, especially in the diagnosis and prognosis of infection. In 1904 and 1905 Arneth gave us an index by which the nuclear changes of the neutrophil might be interpreted. This count, being the first of its kind, aroused much new interest in the leucocytic blood picture; however, it was so detailed and difficult that it proved of little practical importance. In fact Arneth designated more than eighty cell species, thus making it beyond the average technician's ability to do the count.

Many interesting investigations of the leucocytes followed the introduction of the Arneth index. The limited clinical significance of the Ehrlich differential was probably as evident then as it is now. It was obvious that the Arneth count would be of great practical value if it could be made less complicated. Many attempts were made to simplify it but none met with any degree of success until 1912 when Victor von Schilling at the First Medical University Clinic of Berling gave us his modification of the Arneth index. Schilling's method gives us far more information than that of Ehrlich, especially regarding the course of the various infections. Its introduction in this country has been rather slow, but wherever it has been properly explained and demonstrated it has been received with much enthusiasm.

The only essential difference between the Schilling differential and the old differential count as it was outlined by Ehrlich is a division of the polymorphonuclear neutrophils into three classes: juveniles, stabs and segments. The type of nucleus present is, for the most part, the basis for this classification. The polymorphonuclear neutrophils were so divided because their clinical significance depends largely on their degree of maturity or age, and this is mainly reflected by the type of nucleus present. The only other difference in the two counts is that the large mononuclears and transitionals are combined and called monocytes. There is no practical significance in separating these

* Read before a joint meeting of the Los Angeles County Medical Association and the Los Angeles Surgical Society, May 19, 1932.

two cells. Table 1 gives a comparison of the two counts.

Table 1

Ehrlich	Schilling
1. Basophil	1. Basophil
2. Eosinophil	2. Eosinophil
3. Neutrophil	3. Neutrophil
A. Myelocytes	A. Myelocytes
B. Polymorphonuclears	B. 1. Jugenliche (juvenile) 2. Stabkernige (stab) 3. Segmentkernige (seg.)
Lymphocytes	Lymphocytes
Large mononuclears Transitionals	Monocytes

In Figure 1 are sketches of the four neutrophils. These are the cells with which we are most concerned in the Schilling count. The sketches indicate the various nuclear changes of the neutrophil as it grows to maturity. The nucleus of the youngest neutrophil or myelocyte is most often kidney shaped, but may be round or oval; it contains nucleoli. The protoplasm is variable, but is most often a very pale blue with coarse neutrophilic granules. This is an important cell of the bone marrow where neutrophils originate, but is never normally present in the blood. It appears in the blood during the most severe infections or toxic processes.

The juvenile is next in line of development. Dr. Schilling describes it as having a sausage to almost bean shaped nucleus. It takes a slightly more intense staining than the myelocyte nucleus. The juvenile, like the myelocyte, contains nucleoli. This cell is not normally present in the adult blood picture.

The stab type of neutrophil is the stage seen just before the nucleus breaks up into segments that characterize the mature neutrophil. The stab nucleus is dark staining, narrow, often irregular in outline, and assumes several different shapes, e.g. V, S, U and 7. It contains no nucleoli. Two to 5 per cent of these cells are present in the normal blood picture.

The last neutrophil, the segment, is a fully matured cell, being characterized by the presence of two or more segments in its nucleus. These segments are usually connected by a fine filament of nuclear material. Segments normally constitute the largest part of the differential picture, 63 per cent being normal in adults. These cells have finer granules and are slightly smaller than the immature forms.

Notice again that the juveniles, stabs and segments are divisions of the polymorphonuclears and that all neutrophils except segments are immature.

Table 11

				NEUTROPHILS						
CASE	WBC.	B.	E.	M.	J.	ST.	SEG.	LY.	MON.	REMARKS
	7,500	1	3	0	0	4	63	23	6	

Table 11 is a normal Schilling hemogram. B represents basophils (1 per cent), E = eosinophils (3 per cent), M = myelocytes (0 per cent), J = juveniles (0 per cent), St = stabs (4 per cent), Seg. = segments (63 per cent), Ly = lymphocytes (23 per cent) and Mon = monocytes (6 per cent). The neutrophils are all included between the double lines. The dotted line is for descriptive purposes; it divides those cells that are mature from those that are immature; the mature neutrophils

or segments to the right and immature ones: stabs, juveniles and myelocytes, to the left. If there is an increase in the neutrophils on the left side of the dotted line it is spoken of as a nuclear "shift to the left." Arneth was the first to use the term "shift to the left." If there is an increase in the cells to the right of the dotted line it is likewise called a "shift to the right." In almost all infections or toxic processes there is an increase in the immature neutrophils; that is, there is a "shift to the left." The degree of this nuclear shift of the neutrophils has proved to be of the utmost clinical significance, because it is one of our most accurate criteria of the presence and advancement of an infection or toxic process.

At the outset of an infection there is a mobilization of available mature leucocytes. As these are consumed by the septic process there begins a pathologic change in the neutrophils, and then a liberation of immature forms into the blood stream. The first cells to increase are stabs. Schilling believes that this results from an inhibitory or paralytic action of the toxins on the bone marrow, preventing the juvenile cells from passing on to normal stabs and segments. This degenerative effect is thought to involve the neutrophils in both the bone marrow and peripheral blood. The resulting stabs show definite evidence of degeneration in that they are quite fragile and have a tendency to vacuolization. Their nuclei are very intensely stained and assume many odd narrow shapes. These degenerative stabs are to be differentiated from the normal stabs that are present up to 5 per cent in the normal blood picture. The normal stab is the transitional stage between the juvenile and segment. The degenerative stab usually never reaches the segmented stage; that is, it develops to maturity without becoming segmented. A leucocytosis may be absent where there is an increase only in stabs; there may even be a leucopenia. Schilling designates this shift to degenerative stabs without the presence of juveniles as a degenerative shift.

As the infection or toxic process advances

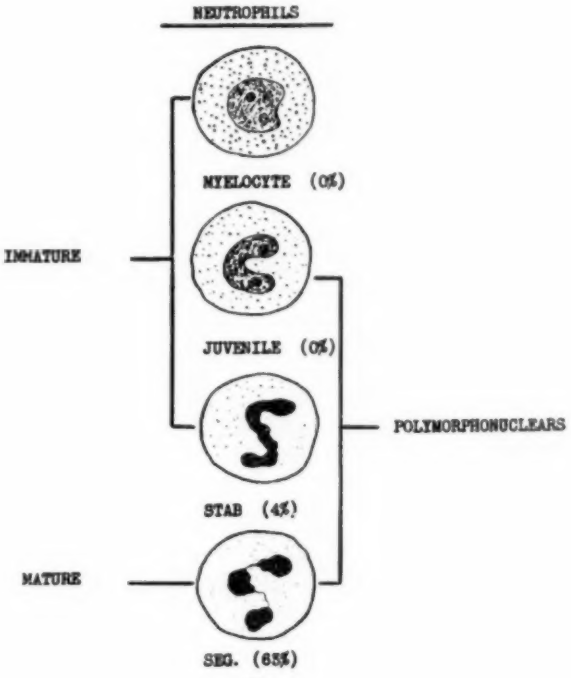

Fig. 1.

there is a demand for more leucocytes and as a result bone marrow activity is stimulated, giving an increasing "shift to the left." Evidence of this is seen in the rising leucocyte count and the appearance of juvenile neutrophils in the peripheral blood. Due to the regenerative activity of the bone marrow, Schilling calls this a "regenerative shift." If the infection still keeps the upper hand and continues to advance, the bone marrow in its effort to meet the demand for leucocytes may release its youngest neutrophil, the myelocytes, into the blood stream. This gives a still greater "shift." Thus we see that the "shift to the left" follows the whole septic process in a definite and significant fashion. The shift to myelocytes is the worst infectious blood picture seen, except in such rare conditions as the agranulocytic and monocytic anginas. Something in the infection of these two conditions completely inhibits the entire myelogenous system.

In Table III are listed a few representative Schilling counts as observed by us in simple acute appendicitis. The normal hemogram is seen at the top of the table. First notice the widely variable total leucocyte count. It was far amiss as a criterion of the infection present in several of the cases; the polymorphonuclear count was also misleading several times. For example in Case 1 the white and polymorphonuclear counts were both practically normal despite the fact than an acute appendicitis was found at operation. The true state of the infection was accurately

TABLE III

SIMPLE ACUTE APPENDICITIS

Case	W. B. C.	B.	E.	Neutrophils				Ly.	Mon.	Remarks
				M.	J.	St.	Seg.			
Normal	7,500	1	3	0	0	4	63	23	6	
1. Mrs. D.	8,150	0	0	0	2	18	55 (75)	20	5	Acute diffuse
2. Mrs. S.	9,200	0	0	0	2	21	63 (86)	13	1	Acute diffuse
3. Mrs. N.	8,300	0	0	0	7	28	50 (85)	12	3	Markedly gangrenous
4. Mr. B.	13,150	0	0	0	4	27	57 (88)	11	1	Operation 18 hours later. See next count.
5. Mr. B.	12,500	0	0	0	10	30	48 (88)	12	0	*Markedly gangrenous* Profuse drainage
6. Mr. G.	23,100	1	0	0	3	19	69 (91)	7	1	Acute diffuse
7. Dr. D.	14,900	0	1	0	0	14	54 (68)	26	6	Acute catarrhal
8. Mrs. A.	15,000	0	0	0	2	16	69 (87)	13	0	Acute catarrhal
9. Master H.	13,900	0	0	0	6	18	61 (85)	12	3	Acute diffuse
10. Master P.	12,150	0	0	0	7	20	64 (91)	9	0	Beginning gangrenous
11. Mr. R.	15,150	0	0	0	3	18	54 (75)	25	0	Acute diffuse
12. Mrs. W.	16,800	0	0	0	7	23	53 (83)	12	5	Peritoneal exudate on appendix

indicated by the "shift to the left." Note next that eosinophils are absent in almost every case. In the beginning of an acute appendicitis, as well as in other acute infections, eosinophils decrease or entirely disappear from the blood picture. These cells are of considerable clinical significance; their presence during an infection is usually favorable and their absence unfavorable. "At the dawn of convalescence," as the attack is subsiding eosinophils reappear in the picture and as complete recovery is approached they may increase considerably above their normal percentage.

During the acute stage of appendicitis the following changes usually occur in the blood picture: (1) Increase in neutrophils, both relative and absolute, associated with a "shift to the left," which is in direct proportion to the degree and advancement of the infection. (2) Decline or absence of eosinophils. (3) Relative decrease in lymphocytes and monocytes. Schilling, in his book "The Blood Picture," terms this phase of an infection "the neutrophilic battle phase." This is the stage of appendicitis that gives us the most concern. The information offered by the blood picture is most often sought for during the "battle phase." During this acute stage when an accurate index of the presence and severity of the infection is so useful and so much needed, the Schilling differential count is found to be most enlightening.

Referring again to Table III note that myelocytes are absent in every case. We have personally never seen an uncomplicated case of simple acute appendicitis in which there were myelocytes. These cells are seen only in the severest infections or toxic processes. The appearance of 1 per cent or more of myelocytes in the blood picture during an appendicitis usually means that a peritonitis has developed. The juvenile neutrophils varied from none, as in the acute catarrhal appendicitis of Case VII, to 10 per cent as in Case V where the appendix was markedly gangrenous and on the verge of perforating. Cases IX and X were in small children; notice that these counts both show a rather marked "shift to the left." In our experience, counts on children show somewhat more marked "shifts" for the same degree of infection than do those on adults.

If an acute attack of appendicitis subsides, with or without surgery, some interesting and definite changes can be observed in the blood picture. Very often one of the first signs that the body is beginning effectively to resist the invasion is a material increase in monocytes. Schilling terms this the "phase of monocytic defense or subjection." Following this, if the attack continues to subside, the left shift recedes, then as recovery is approached the lymphocytes rise and eosinophils reappear. When these changes occur the "phase of lymphocytic cure" has been reached, meaning that the acute infection is entirely overcome. With complete recovery the normal blood picture returns with the exception of an increase in eosinophils and frequently also lymphocytes for a time. Favorable changes in the blood picture, then, are indicated by a recession of the left shift, a decrease in polymorphonuclears, an increase in monocytes and lymphocytes and the reappearance of eosinophils. Unfavorable changes are indicated by an advancing "shift to the left," a rise in polymorphonuclears, decrease in lymphocytes and monocytes, and a decline or disappearance of eosinophils.

In Table IV are a few counts made on cases where a perforated appendix and various degrees of peritonitis were found at operation. Here again the leucocyte counts are widely variable. Frequently the leucocyte count rises as the infection advances, and in a certain way reflects the course of the infection; however, we must always remember that leucocytosis in inflammation is an index to the patient's reaction and resistance and not to the severity of the infection. Through an excessive cell consumption by a severe

septic process there may be a sudden transition from a hyperleucocytosis to a hypoleucocytosis. When this fact became known the total white count lost a great deal of its clinical significance. Such drops in the leucocyte count are the result of an overwhelmed or broken resistance, due usually to a massive, highly virulent infection. Arneth has termed this condition in which the cell consumption exceeds the increased regeneration as "agonal cell liberation." While this is occurring the nuclear shift of the neutrophils moves farther and farther to the left giving us an accurate understanding regarding the advancement of the infection in spite of the variable and often ambiguous total white count. Examples of this are seen in Cases II, IV and VII. When this condition obtains the prognosis becomes much worse and often fatal. Many physicians have at times falsely interpreted the low leucocyte count of "agonal cell liberation" as a good omen. This error has too often proved fatal, especially when the physician was dealing with appendicitis and peritonitis. The

TABLE IV

RUPTURED APPENDIX

Case	W. B. C.	B.	E.	Neutrophils				Ly.	Mon.	Remarks
				M.	J.	St.	Seg.			
Normal	7,500	1	3	0	0	4	63	23	6	
1. Mrs. D.	7,800	0	0	1	14	82 (30)	38	15	2	Patient recovered Stormy conval.
2. Mrs. W.	8,900	0	0	4	28	72 (31)	13	20	4	Death one week postoperative
3. Mr. M.	8,400	0	0	1	11	88 (24)	53	11	0	Bacteriophage used; patient recovered
4. Mr. P.	4,300	0	0	2	25	78 (31)	22	20	0	Fatal prognosis; death three days postoperative
5. Mr. N.	14,350	0	0	0	19	91 (29)	43	9	0	Patient recovered
6. Mrs. B.	25,800	0	0	10	22	82 (40)	20	3	5	Fatal prognosis; death next day
7. Miss M.	6,900	0	0	8	52	80 (20)	8	10	2	Fatal prognosis; death eight hours later
8. Mrs. S.	34,750	0	0	0	18	93 (31)	44	5	2	Good resistance; patient recovered
9. Mrs. K.	10,150	0	0	2	34	82 (36)	12	14	2	*Shift receding.* Operation postponed for 12 days
10. Mrs. K.	9,600	0	2	0	3	83 (17)	63	13	2	Count made day of operation. Walled off Abscess drained

proper use of the blood differential will obviate this error.

It will be noted that 1 per cent or more of myelocytes are present in most of the cases listed in Table IV. The presence of any of these cells indicates that the infection is very severe. Percentages as high as those in Cases VI and VII usually predict a fatal termination, especially if the sum of the immature cells is 60 per cent or more.

Juvenile and stab cells are, as would be expected, quite markedly increased in peritonitis; the more severe the infection the more marked the increase.

Counts IX and X were made on the same patient. Notice the very marked "shift" in count IX. This confirmed the clinical diagnosis of peritonitis. The patient was quite senile and such a poor operative risk that the operation was deferred. A second Schilling count taken about ten hours later showed that the "shift to the left" was definitely receding, indicating to us that the infection was subsiding and probably walling off. The operation was then further deferred until the "shift ceased to recede." Daily counts showed a definite and steady recession of the left shift for the next ten days. During the following two days the shift receded no farther, so the patient was operated upon and a well walled off appendiceal abscess drained through a small stab wound. Had this patient been operated upon when first seen a fatal termination would probably have resulted.

Let us emphasize here that the value of blood findings in many cases is greatly enhanced by frequently repeated examinations. With daily counts the left shift can be nicely plotted and a curve established that will relate with remarkable accuracy the day by day progress of the infection.

In Table V are cases that were all originally diagnosed clinically as acute appendicitis. This diagnosis was questioned after obtaining a Schilling count due to the absence of a "shift to the left" of any consequence.

In Case I there was a high leucocyte and polymorphonuclear count. This was misleading because there proved to be no demonstrable infection present in this patient. The Schilling count indicated the true condition of things. A cystoscopic examination revealed the cause of the trouble to be a stricture of the right ureter due to pressure of a displaced eight months pregnant uterus. Dilatation of the ureter and manipulation of the uterus promptly relieved all of the symptoms that so closely simulated those of an acute appendicitis. Case II is similar except that the trouble was due to a stone in the right ureter. It is surprising how such a stone or stricture will very often cause an increase in the total leucocyte and the polymorphonuclear counts, without demonstrable infection being present. The same is frequently true of biliary stones. The Schilling count is quite helpful in these cases, because unless there is an acute infection or toxic process accompanying the stone or stricture there will be no "shift to the left" of any consequence.

Case III shows a typical count of early internal hemorrhage. These cases usually show a hyperleucocytosis and an increase in polymorphonuclears associated with only a slight "shift to the left," if any at all. There is frequently a persistence of eosinophils. The hyperleucocytosis and increase in polymorphonuclears is often misleading in these cases. The Schilling count does much to clarify this leucocytic picture and differentiate it from those of acute inflammation, e.g. acute appendicitis and acute salpingitis.

We have seen several cases like IV and V. Emergency operations were done for a supposed acute appendicitis. As you see there was no "left shift" whatever. A slightly chronic appendicitis was found in both of the cases.

One of the most important uses of the Schilling method is to indicate in questionable cases whether there is or is not an infection present. We have thus far not encountered an infection of any severity in the absence of a "shift to the left," regardless of the clinical symptoms or the leucocyte and polymorphonuclear counts.

After using the Schilling count in a fairly large series we have concluded that it gives us much more information and is more accurate and dependable than the old differential as outlined by Ehrlich, especially in regard to the course of the various infections. In the patients with appendicitis that were operated upon we were able to foretell the pathology present with greater accuracy than with the old differential count. The Schilling method has a wide range of usefulness in many conditions besides appendicitis. It is especially valuable in tuberculosis. Bredeck, in an article on "The Schilling Blood Differential in Tuberculosis,"[1] concluded that "with the diagnosis of tuberculosis established the method offers us the best single guide in determining the progress of the disease." Further, "it is the most delicate index we possess to interpret the phase and degree of focal activity." Those interested in tuberculosis should read Bredeck's article.

Table V

ALL DIAGNOSED ACUTE APPENDICITIS

Case	W. B. C.	B.	E.	Neutrophils				Ly.	Mon.	Remarks
				M.	J.	St.	Seg.			
Normal	7,500	1	3	0	0	4	63	23	6	
1. Mrs. W.	18,300	0	0	0	0	9 (86)	77	13	1	Stricture of right ureter due to pressure of an eight mo. pregnant uterus
2. Mr. D.	16,500	0	0	0	0	10 (88)	78	10	2	*X*-ray taken later showed stone in rt. ureter
3. Mrs. T.	20,000	0	2	0	2	8 (90)	80	8	0	Ruptured tubal pregnancy, right
4. Mr. F.	12,200	1	1	0	1	6 (83)	76	13	2	Chronic appendix (emergency oper.)
5. Mrs. S.	14,150	0	0	0	0	10 (81)	71	14	5	Chronic appendix
6. Miss C.	12,500	0	1	0	0	7 (84)	77	12	3	Gastroenteritis
7. Mrs. F.	10,900	1	2	0	0	4 (79)	75	18	0	Cyst of rt. ovary
8. Mrs. T.	17,000	0	0	0	1	9 (79)	69	13	8	Hydrops of gall bladder

Expected changes in the blood picture may be absent at times and for unknown reasons. On these occasions it is presumably our limited sphere of interpretation that is at fault and not the blood. We should ever strive to remove these limitations.

May we emphasize in closing that the blood picture should not be used alone in making a diagnosis, but always in conjunction with complete clinical findings.

[1] *Am. Rev. Tuberc.*, 20: No. 1, 1929.

THE PATHOLOGICAL PHYSIOLOGY OF ILEUS AS A BASIS FOR TREATMENT*

GURN STOUT, M.D.

LOS ANGELES, CALIF.

THE condition of impaired motor activity or functional obstruction of the gastrointestinal tract known as ileus frequently occurs in otherwise normal postoperative patients. In these instances a smooth convalescence is converted into one remembered by the patient with "fear and trembling."

The prevalent opinion seems to be that ileus is an uncommon condition. This opinion is, however, erroneous as just the converse represents the truth in the matter. Ileus is a very frequent, if not the most frequent, postoperative complication with which surgeons have to deal. The difficulty lies in the fact that ileus is usually conceived to be a condition of *complete* gastrointestinal paralysis. This is of course the end stage only. The abdominal distention and distress from "gas pains" suffered by many postoperative patients are too often not recognized for what they really are, namely, some of the symptoms and signs of incipient ileus.

Ileus should be considered as a progressively developing pathologic entity. The speed with which ileus develops varies greatly. A few cases rapidly reach the end stage of complete paresis, but the usual course is one of slow and insidious progress, the majority of cases never reaching the final or textbook picture of ileus.

Ileus is a complication of all neglected cases of intestinal obstruction mechanically produced. The segment of gut proximal to the closure is in a state of complete paresis for a varying distance. Restoration of patency relieves only one of two obstructions. The remaining ileal obstruction cannot be ignored without a reflection in the surgeon's mortality rate.

In diffuse peritonitis ileus is practically always to be reckoned with. Unless the virulence of the infection is such as to take

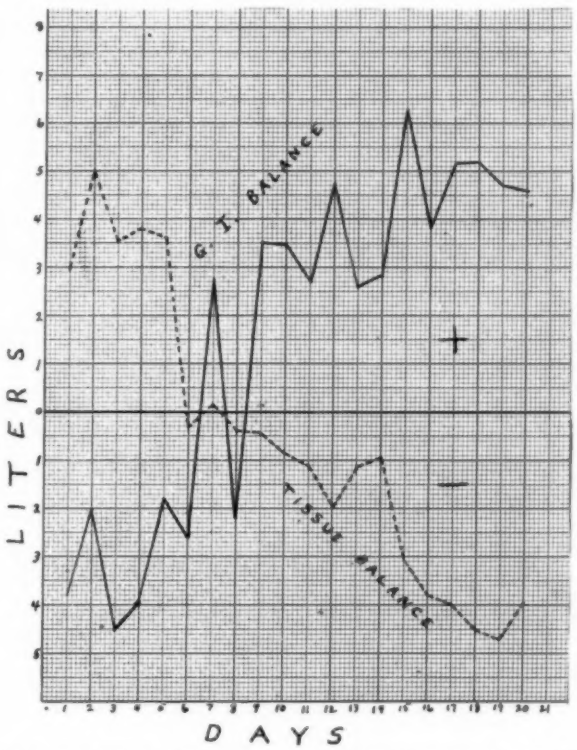

FIG. 1. Case 1. Gastrointestinal balances are plotted in a solid line and tissue balances in a broken line.

the patient within a very few days, death comes as the result of ileus. Peritoneal inflammation may initiate the process of ileus but it does not per se prevent peristalsis.[8]

The onset of ileus is brought about as the result of a peculiarly individual nervous reaction. These individuals are more susceptible to direct and reflex stimulation of the splanchnic nerves of the sympathetic nervous system. It is essentially an autonomic nervous reaction, but experimental observation indicates that there is some

* Read before a joint meeting of the Los Angeles County Medical Association and the Los Angeles Surgical Society, May 19, 1932.

connection with the higher nerve centers. Clinical experience bears this out as one sees this complication most frequently in

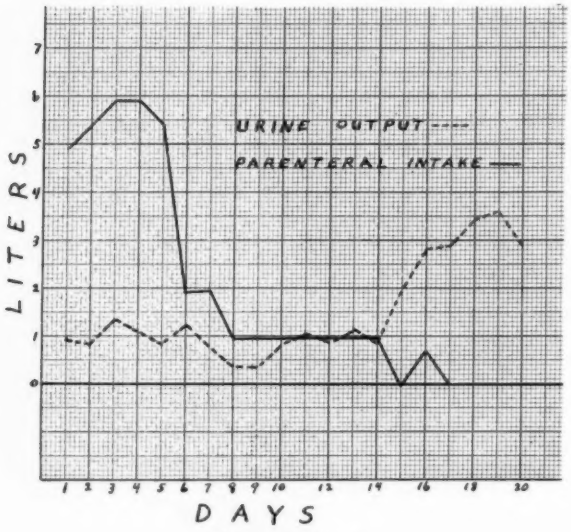

Fig. 2. Case 1.

the "nervous type" of patient. We have seen ileus initiated from the mere application of a body cast.

Splanchnic stimulation usually results, however, from peritoneal irritations such as inflammation, handling and especially cutting operations on the gastrointestinal tract. However, intestinal activity may be inhibited through reflex stimulation of any afferent nerve and we sometimes observe this clinically. As an example of this, one may cite the ileus subsequent to testicular injury and fractures.

Splanchnic stimulation produces a loss of tonicity of the stomach and intestines and an inhibition of peristaltic activity analogous to the refractory period of cardiac muscle. This primary loss of smooth muscle tone is followed by distention.

The manner in which the marked tympanites present in these cases is produced is not known. Stasis may perhaps permit some increase in fermentation. That the meteorism in these cases is due solely to fermentation we cannot for a moment believe. It is our conclusion that the increased intestinal gases are the result of a disturbance in the gaseous exchange through the intestinal mucous membrane brought about by local circulatory deficiencies.

The loss of tonicity impairs the circulation of the gut on the venous side. The tone and contractility of the involuntary or non-striated muscle of the gut wall is just as essential to proper maintenance of the local venous circulation as voluntary or striated skeletal muscle is necessary to proper maintenance of the general venous circulation.

Dehydration is commonly present and contributes to impairment of the splanchnic circulation. It is interesting to note in this connection that the intestine is one of the first tissues of the body to give up water when anhydremia exists.[11]

The passive congestion of the intestinal mucosa produced by the afore-mentioned factors operates to lessen absorption of intraintestinal gases by way of the blood stream. The possibilities for removing gases in this way are not inconsiderable. Deductions from the work of McIver, Redfield and Benedict[9] would indicate that the small intestine alone is capable of absorbing 2560 c.c. of carbon dioxide per hour, 1104 c.c. of hydrogen sulphide per hour, 240 c.c. of oxygen per hour, 128 c.c. of hydrogen per hour and lesser amounts of other gases.

Burget, Martzloff, Suckow and Thornton[3] produced isolated closed intestinal loops in dogs, attaching the loops to the parietal peritoneum in such a position that they could be readily tapped with a syringe. Frequent tappings were required to relieve distention of loops during the first couple of weeks. After this period some dogs required an occasional tapping only and other dogs none at all. The animals requiring no relief for distention showed at autopsy a marked hypertrophy of the vascular system of the loop, indicating the part played by the blood circulation in controlling the intraintestinal gaseous pressures.

It is our opinion that there is also a diffusion of blood gases into the gut lumen. It seems significant that with the exception of oxygen, the gases of the

TABLE I

CASE I

P. O. Day	*Paren. Intake (c.c.)*	*G. I. Balance*	*Tissue Balance*	*Total Intake (c.c.)*	*Urine Output (c.c.)*	*Fluid Balance (c.c.)*
8	*5000*	*−40% or −3820 c.c.*	*+59% or 2980 c.c.*	+1180	1020	− 840
9	*7000*	*−23.9% or −2050 c.c.*	*+71% or 5020 c.c.*	+4950	980	+2970
10	*6000*	*−40% or −4530 c.c.*	*+59% or 3580 c.c.*	+1470	1420	− 950
11	*6000*	*−33% or −3930 c.c.*	*+64% or 3840 c.c.*	+2070	1160	+ 910
12	*5500*	*−24% or −1790 c.c.*	*+64% or +3570 c.c.*	+3710	930	+1780
13	*2000*	*−38% or −2570 c.c.*	−10% or −310c.c.	*− 570*	1310	−2880
14	*2000*	+30% or +2740 c.c.	*+6% or +120 c.c.*	+4740	880	+2860
15	*1000*	*−24% or −2170 c.c.*	−42% or −420 c.c.	*−1170*	420	−2590
16	*1000*	+45% or +3530 c.c.	−43% or −435 c.c.	+4530	435	+3095
17	*1000*	+37% or +3460 c.c.	−86% or −860 c.c.	+4460	860	+2600
18	*1000*	+34% or +2700 c.c.	−110% or −1100 c.c.	+3700	1100	+1600
19	*1000*	+59% or +4765 c.c.	−92% or −920 c.c.	+5765	920	+3845
20	*1000*	+30% or +2600 c.c.	−116% or −1160 c.c.	+3600	1160	+1440
21	*1000*	+27% or +2867 c.c.	−91% or −915 c.c.	+3867	915	+1952
22	0	+90% or +6330 c.c.	−100% or −3020 c.c.	+6330	2020	+3310
23	*750*	+56% or +3864 c.c.	−100% or −3120 c.c.	+4614	2870	+ 744
24	0	+95% or +5135 c.c.	−100% or −3980 c.c.	+5135	2980	+ 155
25	0	+98% or +5220 c.c.	−100% or −4500 c.c.	+5220	3500	+ 720
26	0	+95% or +4700 c.c.	−100% or −4680 c.c.	+4700	3680	+ 20
27	0	+100% or +4600 c.c.	−100% or −3945 c.c.	+4600	2945	+ 655
					Daily Balance	+1069

NOTE: The abnormal figures are in italics, the normal are in Roman.

blood are the only ones consistently present in appreciable amounts in the alimentary tract.[5,10] The distention brought about by the afore-mentioned mechanisms itself further overcomes the smooth-muscle tone and depresses the local circulation to a still greater extent, thus establishing the proverbial vicious circle. The experimental data of Dragstedt[4] indicate that the circulation of the jejunum and ileum is completely blocked at an intraintestinal pressure of 55–65 mm. of mercury.

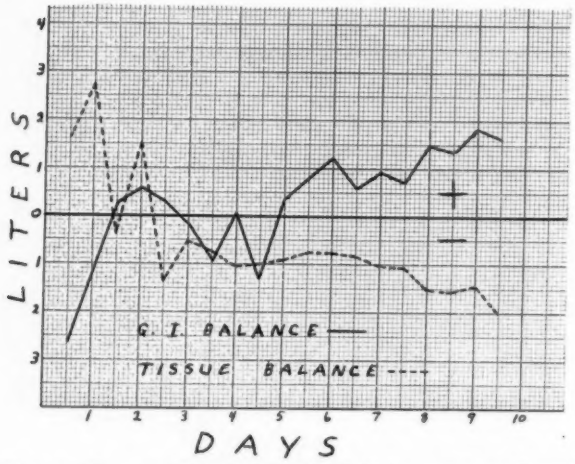

Fig. 3. Case 11. Gastrointestinal balances are plotted in a solid line and tissue balances in a broken line.

It is probable that the decreased oxygen saturation of the blood of the intestines interferes with the functioning of the myenteric nerve plexus and accounts for the disorganization of peristalsis.

The patient's well-known "gas pains" are the result of this disorganized motor activity. The "gas pain" is caused by a peristaltic rush impinging upon a point of obstruction or, what is equivalent, a contraction wave passing caudad in the normal direction meeting one moving cephalad in the reverse direction, thus producing a high intraintestinal pressure in a short segment of bowel.

At this stage in the development of the ileus the Alvarez[1] "gradient of forces" is leveled.

The partial ileus consequent to impairment of the mucosal circulation we at present believe causes the production within that tissue of a specific toxin which has a paralyzing influence upon Auerbach's plexus and brings the case of ileus to completion.

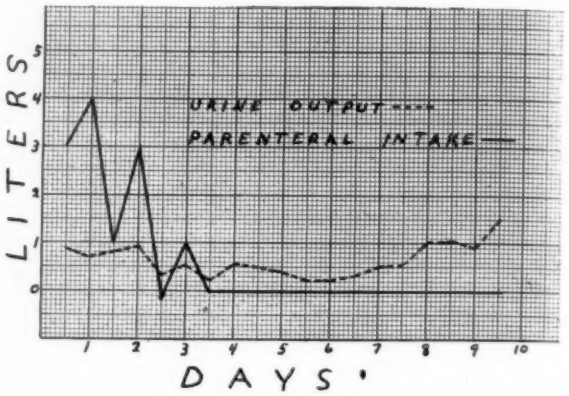

Fig. 4. Case 11.

The normal adult, according to Fries,[5] passes on an average 1 liter of flatus daily. Single discharges varying from 50–500 c.c. with an average of 100 c.c.

It is apparent from casual observation that patients in the early stages of ileus pass amounts of intestinal gases far in excess of this. In many instances therapeutic measures only succeed in softening the abdomen for fifteen to thirty minutes. This can only mean that there is an unusually large amount of gases being produced or introduced into the bowel lumen. It is the misinterpretation of these facts that misleads surgeons into a false sense of security, thus delaying measures for relief beyond the time when they are most effective.

The extent to which gastrointestinal distention is due to the presence of excess liquid in the alimentary canal is not fully appreciated.

The intestinal mucosa normally absorbs all of the water presented to it. It is practically impossible to produce liquid stools by the ingestion of large amounts of water. The normal intestine will absorb water even in the presence of edema. The full burden of regulating and adjusting the water balance of the body devolves on the kidneys.

TABLE II

CASE II

P. O. Day	*Paren. Intake (c.c.)*	*G. I. Balance*	*Tissue Balance*	*Total Intake (c.c.)*	*Urine Output (c.c.)*	*Fluid Balance (c.c.)*
5–6	*3000*	*−137% or −2610 c.c.*	*+52% or 1575 c.c.*	+ 390	925	−1035
6	*4000*	*−31% or −1180 c.c.*	*+69% or 2765 c.c.*	+2820	735	+1585
6–7	*1000*	+5.8% or +290 c.c.	−39% or −395 c.c.	+1290	895	− 105
7	*3000*	+14% or +580 c.c.	*+50% or 1510 c.c.*	+3580	990	+2090
7–8	0	+12.8% or +310 c.c.	−100% or −1375 c.c.	+ 310	375	−1065
8	*1000*	*−8.6% or −160 c.c.*	−55% or −550 c.c.	*− 160*	550	− 710
8–9	0	*−180% or −900 c.c.*	−100% or −775 c.c.	*− 900*	275	−1675
9	0	+5.4% or +80 c.c.	−100% or −1060 c.c.	+ 80	560	− 980
9–10	0	*−121% or −1305 c.c.*	−100% or −1000 c.c.	*−1305*	500	−2305
10	0	+20% or +355 c.c.	−100% or −920 c.c.	+ 355	420	− 565
10–11	0	+64% or +820 c.c.	−100% or −750 c.c.	+ 820	250	+ 70
11	0	+72.8% or +1210 c.c.	−100% or −760 c.c.	+1210	260	+ 450
11–12	0	+56% or +620 c.c.	−100% or −850 c.c.	+ 620	350	− 230
12	0	+100% or +910 c.c.	−100% or −1010 c.c.	+ 910	510	− 100
12–13	0	+100% or +740 c.c.	−100% or −1050 c.c.	+ 740	550	− 310
13	0	+100% or +1480 c.c.	−100% or −1530 c.c.	+1480	1030	− 110
13–14	0	+100% or +1320 c.c.	−100% or −1550 c.c.	+1320	1050	− 230
14	0	+100% or +1850 c.c.	−100% or −1410 c.c.	+1850	910	+ 440
14–15	0	+100% or +1650 c.c.	−100% or −2000 c.c.	+1650	1500	− 350
				Daily Balance		− 428 c.c.

NOTE: The abnormal figures are in italics, the normal in Roman.

The excretion of water as urine is in a generally inverse ratio to the loss of water by way of the skin. The loss of water

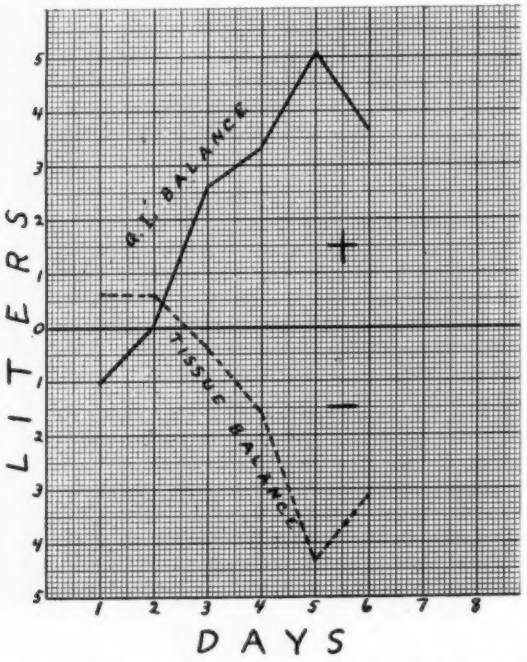

Fig. 5. Case III. Gastrointestinal balances are plotted in a solid line, tissue balances in a broken line.

through the skin is an exceedingly variable one, depending upon such inconstant factors as the environmental temperature, relative humidity and the state of the emotions. The elimination of water in this manner is essentially a heat regulating mechanism and not a means for balancing the water exchange of the body. There is no direct relation between water loss from the skin and total water intake.

Water may be considered as a medium of chemical exchange in the body. The input and output are equal. In other words the balance is zero.

These remarks concerning the water exchange are made as a prelude to further consideration of the water metabolism in ileus.

As previously mentioned there is an unusually large amount of liquid content in the gastrointestinal canal in these cases. Our experience has been that the amount present depends directly upon the severity of the ileus and it usually exceeds 1 liter. We have seen instances in which the liquid content of the intestine approached the total volume capacity of the normal sized

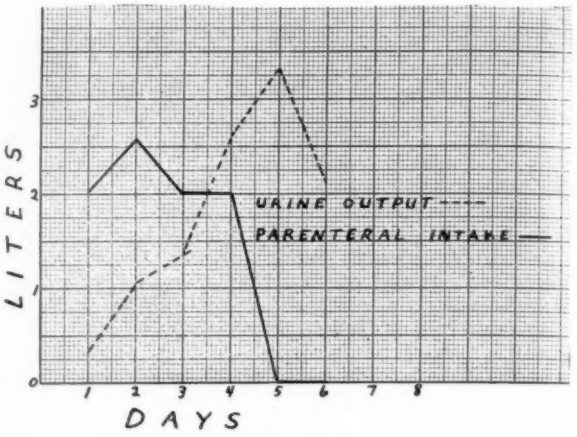

Fig. 6. Case III.

gut. The amount of intestinal liquid found in patients who experienced sudden cardiac deaths and in those dead from causes other than ileus is usually less than 300 c.c. and is frequently so small in amount that it is not easily measured.

To more clearly present the evidence of a disturbance in water metabolism we have prepared a few charts and graphs. The figures for these illustrations have been obtained from water exchange records routinely kept in clinical cases of ileus and arranged for this purpose.

The column headings are, from left to right, postoperative day; parenteral intake; gastrointestinal balance; tissue balance; total intake; urine output; and fluid balance.

The parenteral intake as here used represents the fluid given by hypodermoclysis and venoclysis. The gastrointestinal balance is of course the difference between the quantity of liquid introduced into that tract and the amount removed therefrom. The tissue balance, likewise, is the difference between the quantity of liquid introduced into the tissues by injection and that directly removed from the tissues, namely, the water of the urine and the water losses by way of the skin and lungs. For simplicity the last men-

tioned losses (skin and lungs) may be considered to be 1 liter. For clinical purposes this figure may prove sufficiently accurate.

The error in fluid balance as here shown is rather large. A more accurate balance is obtained by a more careful consideration of such factors as the preformed water, water of oxidation, sensible and insensible perspiration, environmental temperature, relative humidity, etc. The explanation of these factors as related to water balance is complicated and involves a knowledge of biochemistry. Such accuracy in the type of patients under consideration is impractical and not essential to successful clinical use of a water metabolism record in these cases.

It will be noticed that early in the case when the gastrointestinal balances are negative that the tissue balances are positive and later when the gastrointestinal balances are positive the tissue balances are negative. The two sets of figures offset each other with considerable accuracy.

One will observe also that the urine output does not follow the parenteral intake, the urine output being least when the parenteral intake is greatest.

Table III

Case III

P. O. Day	*Parenteral Intake (c.c.)*	*Gastrointestinal Balance*	*Tissue Balance*	*Total Intake (c.c.)*	*Urine Output (c.c.)*	*Fluid Balance (c.c.)*
1	2000	*−50% or −1825 c.c.*	*+33% or +675 c.c.*	+ 175	325	−1150
2	2650	+0.9% or +60 c.c.	*+31% or +625*	+2710	1025	+ 685
3	2000	+44% or +2624	−17% or −345	+4624	1345	+2279
4	2000	+69% or +3330	−78% or −1575	+5330	2575	+1755
5	0	+94% or +5110	−100% or −4320	+5110	3320	+ 790
6	0	+98% or +3700	−100% or −3100	+3700	2100	+ 600
					Daily Plus Balance	+ 826

Note: The abnormal figures are in italics, the normal in Roman.

Comment

From proper water exchange records one may determine the severity of a case of ileus and the daily progress that is being made toward recovery. Also, one may determine when it is safe to administer liquid nourishment and to remove the duodenal tube routinely used in these cases and place the patient on his own.

A carefully kept water metabolism chart enables one to decide on the proper amount of fluid to be given the patient daily. We have even been able to predict the development of edema before it was determinable clinically.

Conclusions and Summary

We feel that the following conclusions can be drawn from the data presented: (1) that the ability of the intestinal mucosa to absorb water is greatly impaired in ileus; and (2) that there is an increased secretion of liquids into the intestinal lumen in ileus.

We have concluded from clinical observation that the essential pathology of ileus may be summed up as a specific toxemia with a disturbance of the water, gas and sodium chloride exchange through the gastrointestinal mucosa caused by circulatory deficiency of that tissue.

Ileus may be defined as a disorganization and impairment of the motor function of the gastrointestinal tract, sometimes resulting in complete cessation of motor activity with consequent functional obstruction, with blood chemistry changes and toxemia peculiar thereto.

FUNDAMENTALS OF TREATMENT[12]

1. Proper preoperative preparation of the patient. This should include mental preparation. The many fears of anticipation harbored by most preoperative patients should be dissipated.

The use of cathartics preceding laparotomies is unnecessary and is to be deprecated.[2] The primary effect of cathartics is followed, as Alvarez has shown, by a refractory period during which there is an inhibition to peristalsis.

2. Early recognition of the signs and symptoms of ileus and immediate institution of adequate therapy. The objective and subjective symptoms of incipient ileus are: nausia, vomiting and "gas pains" later than eight hours postoperatively, restlessness, gastric retention, tympanites and oliguria. Laboratory information is usually not available at this stage.

Postoperative treatment to anticipate ileus should be started immediately in all diffuse peritonitis cases.

3. Proper sedation. These patients are apprehensive, irritable and later excitable from their toxemia. They suffer from insomnia, restlessness and distress from distention. If the latter is relieved they have very little pain and there is no occasion for the promiscuous use of morphine and there is a disadvantage to its use. Rest is, however, imperative and may usually be provided by use of sodium bromide as a basic sedative and the more potent barbituric acid salts as required.

4. Exhibition of chemicals known to have a specific action in inhibiting the toxic process, namely, sodium chloride and sodium bromide.[6]

5. Prevention of toxic absorption from the bowel. This may theoretically be accomplished by introduction of hypertonic saline into the gut to hinder water absorption and administration of sufficient fluids parenterally to cause an active secretion into the intestinal lumen. Provision of means for continuous removal of gastrointestinal contents should be made.

6. Provide adequate facilities for control of intraintestinal pressures. This control may be effected by the use of an indwelling duodenal tube connected to some type of negative-pressure apparatus. We have found the Connel set-up as modified by Robertson Ward[13] very satisfactory.

The operation of enterostomy is very rarely necessary. The equipment mentioned gives better results and is without the inherent disadvantages of the operation.

The Murphy drip does not aid in relieving distention. It tends to maintain reverse peristalsis and its use is consequently inadvisable.

7. Maintain the body chemistry as near normal as possible. Particularly prevent depletion of the electrolytes and guard against disturbance of acid-base equilibrium.

A number of the afore-mentioned measures can be effectively carried out by solutions given through the duodenal tube. For these solutions we have been in the habit of devising formulae and dosages to fit the individual case.

8. Improve gastrointestinal tonicity. In this connection pituitrin has been of little value in our hands and occasionally deleterious. We have used with success a hypodermic consisting of $\frac{1}{50}$ to $\frac{1}{30}$ grain each of physostigmine salicylate, pilocarpine hydrochloride and strychnine sulphate. This combination is effective

in stimulating the motor nerves of the intestines and helps to maintain their tone.

It has been shown by Haywood,[7] that the contraction of striated muscle, at least, is poor in solutions having a low hydrogen-ion concentration.

The solutions in common use for skin and vein injection are in this respect inferior. We have attempted to improve them for this purpose and, we feel, with some degree of success.

The solution we are now using, prepared at our request, has the following composition:

	Grams
Sodium chloride—NaCl	10.0
Potassium chloride—KCl	0.3
Calcium gluconate—$Ca(C_6H_{11}O_7)_2H_2O$	0.25
Di-basic sodium phosphate—Na_2HPO_4	1.0
Mono-basic potassium phosphate—KH_2PO_4	0.1416
Magnesium sulphate—Mg_2SO_4	0.02
Water	1000.0

Laboratory experiments indicate that this solution may prove superior to those now in use as a physiologic medium for the most efficient functioning of muscle tissue.

9. Every effort should be made to improve the circulation in the splanchnic area.

10. Prevention of dehydration and its converse hydremic plethora. The control of the water metabolism in ileus is an exceedingly important one. It is best accomplished by keeping a careful record of the total water exchange of the body, as previously mentioned.

It is well to remember, when giving large quantities of liquids, that in the presence of fever there is a tendency toward retention by the tissues of both water and chlorides.

11. One should constantly endeavor to bend every remedial effort toward a logical treatment of the underlying pathology, as far as we understand it, rather than of the symptomatology presented.

Ileus per se and as a complicating affliction is one of the most difficult with which we have to grapple. The mortality rate is one of the highest. Successful treatment may only be achieved by a comprehensive management, careful attention to details and "Arbeit."

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THE PHENOMENON OF BACTERIOPHAGY*

DONALD A. CHARNOCK, M.D.

LOS ANGELES, CALIF.

FROM the beginning of bacteriological studies, every investigator has at some time noted irregularities in the growth of bacterial cultures. The growth may have been scanty, it may have grown slowly, it may have disappeared either in part or in whole. The literature of bacteriology presents many such observations. Here it has stopped.

In 1909, d'Herelle, then a Commissioner for Sanitation in the French Consular Service, was investigating a disease in Mexico, affecting the locust. In the course of these studies it was found that cultures frequently presented irregularities consisting principally of sterile areas, scattered throughout the agar plates. Such an observation impressed itself upon the mind of this alert Frenchman and researches were begun to investigate this phenomenon further.

Twort, in 1915, described changes in culture growths caused by a "filterable bacterial lysin." In this article, he announces these early observations and shows that a process is going on which attacks the organisms, causing their death. It is generally held that the phenomenon of bacteriophagy was first observed and described by Twort at this time. Unfortunately, his paper did not receive the recognition it is now known to have deserved.

In August, 1916, while studying stool cultures from a patient suffering from severe bacillary dysentery, at the Pasteur Institute Hospital in Paris, this strange phenomenon again presented itself—this time in a more startling manner. A bouillon culture had been filtered through a Chamberland candle and a few drops of this filtrate placed in a young, rapidly growing culture. The following day, the culture had changed from a cloudy condition into a perfectly limpid solution. The bacteria were dissolved. The culture was sterile. Something in the filtrate had stopped the growth of the organisms and made them disappear from the media. Thus was developed the first bacteriophage suspension. The phenomenon of bacteriophagy was a reality.

Another important observation was now made. A few drops of the clear lysed media were added to a second culture. In due time this, too, became clear. Then a few drops of the second media were added to a third culture. Again the culture cleared. Thus the phenomenon of bacteriophagy is, in reality, a double reaction:

1. The bacterial cells are dissolved.
2. In the course of the dissolution the bacteriophage regenerates itself. This action goes on through successive generations of cultures and is called serial passage.

The bacteriophage is present everywhere. We can isolate it from the intestinal contents of both man and the lower animals. We find it in the blood and urine of convalescent patients. It is found in the soil, in river water, in sewage, in salt water close to shore, in fact, everywhere that the waste products of the animal world are found, there will be bacteriophage. It has been reported with bacteria parisitic for plants.

The bacteriophage is obtained from these sources. Cultures are made and are passed through collodion filters. By this type of membrane, the bacteria are kept back within the candle but the bacteriophage is allowed to pass through the fine interstices

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of the filter with the culture medium. This process can be carried on indefinitely, new cultures being lysed and filtered. The extent to which the bacteriophage will multiply depends upon the total number of bacteria capable of undergoing bacteriophagy.

There are a few simple conditions governing the phenomenon:

1. The process goes on best in an alkaline reaction varying between P_H 7.2 and 8.2.

2. The optimum temperature for the action varies with the optimum temperature for the development of the specific bacteria involved.

3. Addition of antiseptics or dyestuffs may alter the virulence of the bacteriophage.

4. The process is, to some extent, affected by normal blood serum, inflammatory exudates, ascitic fluid and urine but is unquestionably inhibited by bile.

5. Bacteriophagy takes place, almost without exception, during the period of division of the organism.

6. The phenomenon acts under aerobic conditions.

7. The 'phage is more or less specific in its action.

What the bacteriophage really is, as yet, remains an enigma. At the present time, several hypotheses have arisen regarding its nature. The principal controversy, in connection with these studies, relates to the theoretical question as to the actual nature of the agent. Of all the theories advanced to explain the nature of bacteriophage, none seems to fit the sum total of observations better than d'Herelle's theory of a living virus.

Whatever the nature of the bacteriophage, it has certain measurable properties. The dimensions of the 'phage corpuscle are, approximately, $5\mu\mu$ based on filtration through graded collodion membranes. It is destroyed by temperatures above 65–75°C., depending on the strain of 'phage.

The addition of a bacteriophage to a young bacterial culture serves to speed up the rate of bacterial multiplication. This is accompanied by a marked influx of water into the cell, causing it to swell and finally burst. This destruction of the bacteria and the regeneration of the 'phage, at the expense of the bacteria, represents the mechanism of bacteriophagy.

When a patient is attacked by an infectious disease, one of three processes goes on:

1. The disease is overwhelming and the patient dies.

2. The patient survives the attack, in which case he often obtains an immunity to the causative organisms which protects him from successive attacks.

3. The disease may reach a chronic state in which there is a balance between the activity of the organism and the resistance of the host.

In an exactly parallel way, the bacteriophage is an agent producing within the bacterium itself a disease called bacteriophagy. Here, again, the three processes go on:

1. The death of the organism, due to dissolution by the bacteriophage.

2. Recovery of the organism, in which case the bacterium may develop a resistance to the 'phage which protects it from further action and often affords a true immunity. This can be illustrated by the inoculation of two culture tubes with 'phage. In the first, there is complete and constant lysis of the bacteria; while in the second tube the media will clear for awhile and then again become cloudy. This cloudiness is caused by *secondary cultures* resulting from the growth of organisms with immunity to the bacteriophage. These organisms have acquired a resistance. The number of bacteria becoming resistant is greater as the virulence of the 'phage decreases. These refractory organisms are thus enabled to destroy within themselves the 'phage just as a convalescent patient destroys the organisms causing his disease.

3. In the third condition, we have a more theoretical state. Bacteria and bacteriophage can live together in a state

of symbiosis in which each attenuates the actions of the other. This theory has been advanced by d'Herelle as explaining the chronic state. The condition shows a weak bacteriophage which cannot kill the organisms but can, however, so attenuate them that their action is not fatal to the host.

In discussing the use of bacteriophage therapy, it is only possible here to point out the broad avenues of investigations which are being undertaken. In view of the fact that but fifteen years have elapsed since the phenomenon became known, much has been accomplished.

Disorders of the enteric group were the first to be studied and it is in this field that the most pronounced success has been attained. Since 1919, experiments upon patients affected with bacillary dysentery have been in progress. This method of treatment has been applied on a large scale, principally in the Soudan and in South America. In Brazil, this work has been conducted by da Costa Cruz at the Oswaldo Cruz Institute. As a result of these extensive and controlled experiments, the Brazilian Public Health Service has abandoned all other modes of treatment and sends dysentery bacteriophage all over the infected areas of Brazil.

In India, the treatment of Asiatic cholera has shown good results with bacteriophage. While in the controls 68 per cent of the patients died, those taking bacteriophage showed a mortality of only 8 per cent, as reported by the Indian Medical Service. In infantile diarrheas, d'Herelle reports several hundred cases with good results, using a polyvalent bacteriophage administered by mouth. The results in the typhoid and paratyphoid group are as yet experimental but progress is being made. At the present time, both the oral and the intravenous route are being used for this group. By the oral route, the course of the disease has been attenuated with lower fever and no complications. On the other hand, by the intravenous route, the results have been either a brilliant cure or failure, and in about equal numbers. The solution of this problem seems to be a use of both methods of administration.

In the genitourinary tract, there is a rapidly growing literature which shows that definite help is being given to this field. Bacteriophage has been successfully used in pyelitis and cystitis. As may be expected, the results are more beneficial in the acute cases.

Infections due to the pyogenic cocci are numerous. This, like the colon group, shows a heterogeneous collection of strains which exhibit a considerable degree of strain specificity. The 'phage is now being successfully used in furunculosis, carbuncles, infections of the extremities, some skin infections of coccus origin, in various forms of otitis and mastoiditis. In osteomyelitis, the use of 'phage therapy was initiated by Marceron, Chief of Clinic at Hôpital St. Louis in Paris. This has been followed by others, notably by Albee in this country.

In the preparation of bacteriophage, it is the practice to dispense the product in a peptone solution. Two types are available:

1. The univalent preparation, containing a single strain of bacteriophage; the use of this type is of course limited and should be used only where tests can be made to determine its specificity.

2. The polyvalent preparation, which contains a pooled mixture of various strains; this type can be used without tests for specificity and is the preparation of choice for emergency use.

The mode of administration of bacteriophage is that which will bring about a rapid union between the organisms and the 'phage. In the enteric group, the 'phage is given by the mouth. In genitourinary disorders, the 'phage is instilled directly into the renal pelvis or the bladder. In the coccus group, the 'phage is placed at the seat of the infection, either by compresses or by needle injection. In septicemia, the 'phage may be administered intravenously, care being taken to protect against anaphylaxis from the peptone.

d'Herelle advises mixing the bacteriophage (using generally 2 to 5 c.c.) into 500 c.c. of physiological salt solution, the whole being introduced intravenously, very slowly. Some laboratories are now employing media with only a trace of peptone, especially for intravenous use.

In wound infections, we have had surprisingly good results from administration of the bacteriophage directly into the wound. Care must be taken to have the wound relatively free from antiseptics. Our practice is to lave the wound with sterile water made alkaline by the addition of a little sodium bicarbonate. This removes the heavy pus and debris and allows the bacteriophage to come into direct contact with the wound. A polyvalent preparation should be used. In abdominal infections, including peritonitis, the 'phage can be placed directly into the peritoneal cavity. It is the practice, in some surgical clinics, to pour a few tubes of virulent polyvalent bacteriophage directly into the abdominal cavity in cases of ruptured appendixes or perforating ulcers.

There are a few general rules to follow in the administration of bacteriophage:

1. Either the strain must be specific or polyvalent 'phage must be used.
2. It must be of active virulence.
3. The surroundings should be alkaline.
4. The locale should be reasonably free from antiseptics which may inhibit the bacterial growth and thus destroy the ability of the bacteriophage to regenerate.

To obtain matched bacteriophage, it is necessary to send a culture to the laboratory preparing the 'phage. If a polyvalent strain is to be used, it is necessary only to know the group of the organisms, although, if time permits, it is more satisfactory to determine the potency of the mixed strain by testing its lysing properties against known cultures.

We cannot predict, at this time, to what lengths bacteriophage therapy will lead us. As each new fact is added to this intriguing story, narrower becomes the gap between the theoretical and the practical. Perhaps this new light will turn out to be but a will-o'-the-wisp, leading us further into darkness. Many are the scoffers who predict this end. There is more than a good possibility that this new phenomenon will grow in importance until it becomes the chief cornerstone in our wall of defense against infection. Even in its infancy, it is an important addition to our bacteriological armamentarium.

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THE DIFFERENTIAL DIAGNOSIS BETWEEN

ACUTE APPENDICITIS AND INFLUENZAL MYALGIA

COMMANDER J. J. A. MCMULLIN, M.C., U.S.N.

LEAGUE ISLAND, PA.

THE points of similarity between certain cases of influenza and acute appendicitis prompt me to call attention to a resulting error in diagnosis which is frequently made.

Every winter I am called upon to operate upon patients with influenza showing abdominal symptoms, which have been interpreted as acute appendicitis. The type of influenza to which I refer is quite typical. The patient frequently has chilly sensations at the onset, followed by coryza, mild bronchitis, headache, and muscular pains. The temperature ranges from 100 to 103°F. There is a leucocytosis, sometimes as high as 20,000.

It is quite certain that the myalgia which affects the eye muscles, the muscles of the back, the neck, etc., likewise at times affects the muscles of the anterior abdominal wall.

When this myalgia is limited to the muscles of the right anterior abdominal wall, and particularly the lower anterior half, the diagnosis of acute appendicitis is made forthwith. This diagnosis apparently is supported by a frank leucocytosis ranging from 12,000 to 20,000. How then do we know we are not dealing with acute appendicitis?

First, we have elicited the signs and symptoms of an acute infectious disease, which we call influenza. This should put us on guard.

Second, muscular pain is not limited to the abdominal wall, but is felt in the back, frequently in the eye muscles and also in the muscles of the leg.

Third, muscular rigidity is absent. A rough, examination may evoke muscular spasm, but a skillful, gentle examination will determine that the muscular rigidity accompanying peritonitis is absent.

Fourth, tenderness over the appendix is either absent or the tenderness can be elicited over the muscle group affected. It is not the same in either degree or kind as that felt by the patient with acute appendicitis. By gentle insertion of a finger in the right external inguinal ring and the patient being told to cough, as one does in examination for right inguinal hernia, the examining finger is brought in close contact with the cecum and appendix without pressing upon the overlying abdominal muscles. Tenderness thus elicited (examining the left inguinal ring in a similar manner as a control) is a valuable sign of appendicitis when the appendix is in its customary position adjacent to the internal ring. This sign is invariably negative in influenza, rarely negative when acute appendicitis exists.

Fifth, the sequence of symptoms in acute appendicitis differs from the onset of influenzal myalgia.

Naturally the question arises: how about the leucocytosis? An average was taken of the blood counts and differential counts for 63 patients whose final diagnosis upon discharge from the U. S. Naval Hospital, League Island, Pa., was influenza. The average white count was 8895. The average differential count was: Polymorphonuclears 66.6 per cent; lymphocytes 29.5 per cent; large mononuclears 2.9 per cent; transitionals 1.8 per cent; eosinophiles 1.8 per cent; mast cells 2 per cent; basophiles 1.33 per cent. The highest white count in the series was 20,400, the lowest 5000.

(Concluded on p. 300.)

ALCOHOL INJECTION FOR PROLAPSE OF THE RECTUM*

EUGENE B. POTTER, M.D., AND JOHN M. WELLMAN, M.D.

ANN ARBOR, MICH.

THE treatment of prolapse of the rectum, especially the variety commonly seen in children, has been discussed in the literature rather infrequently with about an equal division of opinion regarding the surgical and the non-operative methods of dealing with the lesion. The condition is often seen in large pediatric clinics, and is treated by many methods, varying from the simplest to the most radical procedures. We present a small series of cases treated by the injection method in support of the non-operative form of treatment.

Findlay[1] first reported a technique for the injection of alcohol in the treatment of rectal prolapse in a group of children, giving credit for its origin to D'Espine from whom he learned it. The principle of the submucous injection of an irritating substance was not new, however, since Langenbeck[2] had used injections of ergot, glycerine and alcohol, while others have advised the use of strychnine, white oak bark and carbolic acid, none of which seemed to be entirely safe or sure of producing a cure. Macewen[3] reported the satisfactory cure of a difficult procidentia in a sixty-six year old man by repeated injections of phenol and hammamelis. Hanes[4] using injections of dilute hydrochloric acid in the treatment of pruritus ani, found it to be of value also in cases with rectal prolapse, and reported excellent results. Applehaus[5] adopted the same technique and obtained good results in two adult cases with severe prolapses by injections of dilute hydrochloric acid into the submucous and perirectal regions.

All forms of injection treatment for prolapse of the rectum occupy a middle position between a strictly non-surgical attack, through correction of the diet, habits (Goldbloom[6]) and co-existing disease, and the more radical surgical procedures described for the relief of the condition, and summarized by Alexander[7] and Maes, Urban and Rives.[8] Linear cauterization of the rectal mucous membrane, reported by Corbett[9] with good results, is an example of a simple surgical procedure, efficacious and lacking in undue surgical risk.

There is no doubt that for the more severe types of prolapse, with downward displacement of all the coats of the bowel, and classified by Martin[10] as "procidentia," some of these more radical methods are necessary. The usual form of prolapse seen in young children, however, consists of downward displacement of the mucous membrane only, and in these, as well as in some of the more severe cases, the reported results of alcohol injection are so satisfactory as to make radical operative procedures appear to be unwarranted.

Findlay[1,11] in two reports described the treatment of prolapse by the injection of alcohol in 41 cases, with 90 per cent cures. Alexander[7] treated 11 cases, 10 of which were successful. Nixon[12] reported 9 cases cured following injection with the exception of one which recurred following whooping cough, and Fraser[13] treated 50 children by the D'Espine method with 100 per cent good results. Brown and Drake[14] cured two children by this method and gave the autopsy findings in a third who died of pneumonia five days after the injection. They found that the prolapse could be reproduced with difficulty and the microscopic studies showed small hemorrhagic areas and fibroblastic proliferation at the injection sites.

* From the Department of Surgery, University of Michigan.

We have treated, over a four year period, 13 consecutive cases of prolapse of the rectum by the submucous injection of alcohol (see table) and have followed the technique described by Findlay.[1] The lower bowel is emptied by an enema, and the patient anesthetized, usually with nitrous oxide and oxygen. If the prolapse is down, it is reduced and the perineum is prepared with iodine and alcohol. The finger is inserted in the rectum to serve as a guide, and a long aspirating needle (calibrated in centimeters) is introduced into the perirectal tissues on both sides of the rectum a distance of 7 to 8 cm. The punctures in the skin are made about 0.5 cm. lateral to the anal margin, and the point of the needle is guided to a position just outside the rectal mucous membrane. Alcohol, 1.5 to 3 c.c., is injected on each side. A pad is placed in the perineum and the buttocks are strapped firmly together, recumbency being maintained for seven to ten days on a Bradford frame, during which time the child is kept on a diet of boiled milk. If the bowels move before a week, the recumbent position is not altered, and the feces are allowed to escape around the pad which is then replaced.

In the group treated by us, the age varied from one to thirteen years and the duration of the prolapse from thirteen days to four years. In most cases the prolapse involved the mucous membrane only although one patient had a severe procidentia with extrusion of the sigmoid as well as exstrophy of the urinary bladder and other congenital abnormalities. A definite cause of the prolapse could be ascertained in but 5 of the 13 cases, a marked diarrhea being responsible in 3 instances, in one the onset had followed typhoid, and in one congenital anomalies were present. Some diarrhea had occurred in others which may have been a contributory factor in the production of the lesion. Among the most common etiologic factors in rectal prolapse, are unusual intra-abdominal pressure, weak musculature, lax mesorectum, diarrhea, constipation, hemorrhoids and polyps.

A cure was obtained in 11 cases, or 85 per cent, although several required a second injection for a satisfactory result. This may probably be explained by the fact that the treatment was given, in some cases, by the younger members of a constantly changing surgical staff whose experience was amplified by the first procedure.

One failure occurred in a seven-year-old child confined now to an institution with an organic brain lesion. Radical operation failed following unsuccessful injection and any further attempts at cure would be futile in the opinion of the present attending physician "because of the pernicious habits of the child." The other recurrence was in a nine-year-old child with a two-year-old prolapse only recently treated, and we anticipate a satisfactory result with another injection.

In none of these cases have there been complications in any way associated with the injection treatments. Children accustom themselves readily to recumbency on a Bradford frame, and in most instances show no evidence of discomfort or harm from the enforced constipation over a seven to ten day period. Care should be taken to avoid diarrhea or constipation after the patient returns home. A diet containing adequate bulk is desirable and should be supplemented by sufficient doses of mineral oil if constipation is present. The habits of the child at stool should be observed and carefully supervised.

Findlay's[11] theory that the injection of alcohol anchors the bowel at the point of injection by cicatrization appears logical and has abundant clinical evidence in its support as well as the microscopic findings of Brown[14] mentioned previously. Reduction of the prolapse with resulting improvement in the sphincter tonus is doubtless helpful, but this method of treatment used alone usually proves to be only palliative in a well established

Table 1

Initials	Age Sex	Duration	Degree of Prolapse	Cause	Initial Injection	Check-up
N. O. 163140	4 F	1 year	?	Diarrhea	3–16–27 1.5 c.c. 2 sides*	Cured
J. R. 168863	3 M	2 years	Mucosal	Diarrhea	5–27–27 1.5 c.c. 2 sides*	Cured
E. C. 174560	4 F	2 years	1½ in.	Dysentery	7–14–27 1.5 c.c. 2 sides*	Cured
F. B. 203208	3 M	?	Mucosal	Unknown	10–11–28 1.5 c.c. 2 sides*	Cured
D. B. 120827	4 F	13 days	Mucosal	Unknown	10–25–28 2 c.c. 2 sides	Cured
U. W. 131526	13 M	7 years	1 inch	Typhoid age of 6 years.	11–30–28 2.5 c.c. 2 sides	Uncured. Insane.
G. B. 234279	5 M	4 years	1½ in.	Unknown	2–15–30 3 c.c. 2 sides	Cured
R. G. 236359	3 M	1½ years	½ inch	Unknown	3–24–30 3 c.c. 2 sides	Cured
N. C. 248656	3 M	?	?	Unknown =	9–18–30 2.5 c.c. 2 sides	Cured
J. C. 251285	2 M	1 year	1 inch	Unknown	10–25–30 2.5 c.c. 2 sides*	Cured
M. K. 254867	1 M	2 weeks	Procidentia of sigmoid	Congenital anomalies. Exstrophy of bladder.	1–15–31 2.5 c.c. 2 sides*	Cured
R. L. 263097	5 M	2 years	2 inches	Unknown	5–8–31 3.5 c.c. 2 sides	Cured
A. Z. 279161	9 F	2 years	Mucosal	Unknown	11–30–31 3.5 c.c. 2 sides	Recurrence

* Reinjected.

prolapse. Because of its simplicity and negligible risk the injections may be repeated when the first treatment fails with an increasing probability of success attending the second injection.

Radical operations, many of them formidable procedures for use in children, seem to be unjustifiable in most instances when we have at our disposal the injection method, which in the great majority of cases has proved to be a safe, simple and effective form of treating rectal prolapse.

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CONCLUSION OF COMM. MCMUELIN'S ARTICLE*

Unlike the epidemic type of devastating infection that scourged the entire world in 1918, the condition called influenza which we see at the present time shows a normal leucocyte count or a leucocytosis, and only occasionally a leucopenia. This fact is not generally appreciated and cannot be emphasized too strongly.

CONCLUSIONS

1. Myalgia of the abdominal muscles occurs in influenza.

2. Sometimes a leucocytosis is found associated with myalgia of the abdominal muscles resulting in an erroneous diagnosis of acute appendicitis.

* Continued from p. 296.

REASONS FOR THE

RELIEF OF PAIN IN CANCER BY CALCIUM*

R. J. BEHAN, M.D., DR. MED. (BERL.), F.A.C.S.

PITTSBURGH, PA.

IF we admit, and from our experience it seems to be definite, that calcium has a great influence in relieving the pain due to cancer, it then is important to determine the reasons for this relief. To facilitate the solution of this problem of calcium amelioration of pain in an area of carcinoma, it is necessary to carefully review all known facts associated with the origin and control of pain in cancer. The following are of interest:

1. In cancer, pain is probably primarily due to *changes in the metabolism* of the cancer tissue so that deleterious products, *principally lactic acid*, are formed in such concentration that the irritative stimuli from their presence is sufficient to pass the threshold for pain perception. Cancer and the surrounding tissue juices have a reduced alkalinity due to the presence of lactic acid. The lactic acid in the tissues may be reduced by giving calcium in intensive doses. The calcium unites with the lactic acid and forms the less soluble calcium lactate. (See the paper by A. S. Minot on the hypoglycemia produced by carbon tetrachlorid poisoning and its relief by calcium medications.[18])

2. The *restricted pain* reflex may be the result of changes produced in the degree of irritability of the nerves (circumferential) in a cancerous mass by the administration of calcium so that the threshold of reaction to a pain-sensory stimulus is increased.

3. It is also conceivable that a lessened perception to pain-exciting stimuli is produced by the action of calcium, on the *pain-receptive centers in the brain.*

In order to understand the process by which calcium controls the pain of cancer, it is necessary to study the pathologic changes which occur in malignant tissue, and which may be associated with or be causative of powerful pain-producing stimuli. Then, after determining the character and extent of these changes, it will be necessary to review the probable manner by which calcium influences them so that the pain which ordinarily is associated with such changes does not occur.

It may be assumed that the pain which is present in patients, and is due to cancer, may be the result of (1) mechanical pressure, or (2) chemical irritation.

The cells composing a cancer are larger than are the normal cells of the same tissue. This increase in size is reduced to some extent at least, by calcium, for under the administration of calcium a cancerous tumor becomes smaller.

Thus, the increased volume content of the cells of cancer tissue which cause pressure and irritation to the fine nerve fibrils distributed in the tumor is relieved by calcium. This conclusion is in accord with the findings, that in cancer patients the serum contains less calcium; this is one of the reasons for the increased volume of cancer cells—for it has been demonstrated that slices of a transplantable tumor, immersed in an acid mixture, imbibe water and that preliminary treatment with calcium solution restrained this imbibition and reduced the volume mass of the tissue. This decreased volume mass if it occurs in cancer when there is an increased

*The same reasons may be given as a basis for the use of calcium as a definite beneficial and, in some cases, curative remedy in the treatment of cancer. Based upon the premises as given in this paper and on others to be described in another paper, shortly to be published, I have been using calcium since 1926 in the treatment of cancer, with very gratifying results.

content of calcium would reduce the pressure on the fine nerve fibrils and in this way lessen the pain.

From a review of experimental evidence it is difficult to formulate a judgment as to whether the activity of a cancerous growth is contingent on cell permeability, or whether the converse may be true, namely, that permeability may be a result of the growth. In any case there is an increase in permeability, which it is reasonable to conclude leads to hydrops of the cancer-tissue and *a priori*, an increase in size of the tumor mass, with pressure on the contained sensory terminal fibrils.

This is in complete accord with biological science for it has been shown that all rapidly growing tissues, whether cancerous or normal, as in the embryo, the spleen, the testes, etc., have a higher degree of imbibition for water than have slower growing tissues. This undoubtedly is due to changes in the permeability of the cell membrane, and indicates a close association between permeability and growth.

It is of importance for a thorough understanding of our theme to know that the water content and the electrical reaction of the cell are both influenced by calcium. Variations of water content and electrical reaction have a profound effect and induce an imbalance in the cell metabolism with the production of deleterious substances. The osmotic relationship of the cell to the surrounding media is also disturbed and the fine adjustment of the intercellular reactions is disjointed. When osmotic relationship of the cell to its surrounding media is modified it causes irritation of the peripheral sensory nerve terminals and the production of pain. These conclusions are confirmed by the findings of J. C. Hemmeter,[12] who showed that the osmotic pressure of cancer cells is less than that of normal cells, as he demonstrated in the experiment in which he placed "carcinoma cells of the mammary gland in a physiological salt solution, and found that they shrank, and normal cells swell when placed in cancer juices."

That calcium has a vital influence on the permeability of a cell is believed by Blair Bell,[4] who states that calcium prevents even temporary or incipient permeation of a cell membrane; substantiating this was the demonstration by M. A. Magath,[15] that the permeability of cancer cells was reduced by calcium chloride, which even in isotonic solution greatly decreased the imbibition of cancer tissue, but, rather interestingly, increased that of normal tissue.

The relationship of cancer growth to cell permeability is further indicated by the work of Cramer,[8] who also showed that calcium chloride reduced the degree of imbibition of cancer cells and at the same time the rate of growth and in another experiment he found confirmation of the influence of calcium on cellular activities.

REMOVAL OF CHEMICAL IRRITATION AND PAIN AMELIORATION IN CANCER

Substances which may result in irritation of the terminal sensory fibrils and cause pain are produced by changes in the chemical constituents both of the tumor and of the surrounding tissue juices. These changes are a consequence of tumor activity.

The most active metabolic process in cancer tissue is glycolysis and the change of sugar into lactic acid, carbon dioxide and water. How far the lactic acid is concerned in the irritation of sensory nerves and the transmutation of impulse so produced into pain impressions, is not as yet determined. However, it must be accepted as a fact that the pain production in cancer tissue is associated with irritation of sensory fibers in and around the cancer mass and it is conceivable that this irritation is closely associated with disturbances in osmotic pressure and electrolytic reactions.

Disturbances of this character as definite sources of pain production are quite conceivable, if we compare the pain of cancer with the severe pain produced by osmotic changes intentionally induced, as,

for instance, the pain caused by the hypodermic injection into tissues of solutions not isotonic with the plasma of the tissues. It is a clinical observation that if there is a marked variation in the osmotic pressure of such an injected solution and it is either higher or lower than that of the tissues into which it is introduced, pain always results. Especially painful is the injection of an acid solution. So too, in cancer, it is conceivable that the metabolites of the cancer cells, of which lactic acid is the most prominent, are factors in producing disturbing and irritating changes in the surrounding media or even in the cancer tissue itself. These changes, which are deleterious and destructive to the tissues of the affected area, must be causative agents of the pain; therefore, in order to influence, at its source, the pain of cancer lesions, it is necessary to control or to *regulate the metabolism of the cancer tissues.*

The metabolism of cancer tissue is predominately that of glucose, so that the relief of pain in cancer patients who are under treatment with calcium may also be related to the direct action of calcium on the glycolysis of cancer cells. With the administration of calcium, corrective changes in the pernicious metabolism of the tumor cells are induced; these changes are favorable for normal metabolism and are inductive of corrective activities, and as a consequence deleterious products are not formed in such abnormal concentration and pain production is not so marked because the irritative stimuli from their presence are of insufficient intensity to pass the threshold for pain reception; or, as is just as probable, the irritative products resulting from the disturbed metabolic activity of the cancer cells may be rendered inactive by the administration of calcium[28] as far as pain production is concerned.

Experimental evidence of the effect of calcium on glycolysis has been offered by many investigators, including N. Waterman,[29] who determined that calcium inhibits glycolysis, and it was further evident to many others that glycolysis is a definite reaction of the tumor cells and is hindered by increase of calcium. Jowett and Brooks have had contradictory results. They have found that the high calcium content in Ringer's solution at pH 7.2 had no effect on glycolysis.

Lactic acid, the result of intracellular glycolysis, is known, when in solution in the tissue juices surrounding a cancer mass, to cause a disintegration and solution of the surrounding tissues and to lead to an even wider destruction; therefore, an increased production of lactic acid profoundly disturbs the relationship of the tissues, both to each other and to the surrounding plasma. This changed relationship, it is logical to assume, may have an unbalancing effect on the reactions and relationship of the tissues to each other. This abnormal reaction disturbs the local sensory nerve receptors to such a degree that they respond with the sensation of pain.

Reduction in the pain reaction of patients with cancer who are treated with calcium may also, in part, be hypothesized upon, (1) changes in the irritability of the nerves in the cancer area; (2) changes in the conductivity of the nerves from the cancer area to the brain, and (3) a decreased activity of the pain perception centers in the brain.

It was formerly thought that cancer cells had no direct relationship with the nerve centers, and that all sensory and reflex reaction in cancer tissue resulted from pressure on the nerve terminals or from stimulation from the products of metabolic activity. If this were true, cancer cell growth would not be influenced by stimuli coming through the nervous system, and conversely the cancer cell itself, would have no influence upon nerve reactions, except indirectly through the products of its activity. Evidently such conclusions are not entirely true for H. Oertel[19] described non-medullated fibers in cancer tissue, and showed direct contact of these fibers with the cells. Marpurgo[16] also found nerves in tumors. Hugh Young was one

of the first to come to the conclusion that a tumor may have an inherent nerve supply.

Further, the growth of cells, it has been demonstrated, is to some extent under control of the nervous system, this conclusion is confirmed by the experimental results of L. Pearce and C. M. Van Allen,[20] who found that cervical sympathectomy caused the growth and malignancy of transplanted carcinoma on the head to be greater as to percentage of successful transplants and mortality, and in the number and the extent of metastases, as compared with their controls.

This corresponded with the results of W. N. Ssokolow,[25] A. Remond,[22] and others who found that in animals in whom they separated the tumor from the cerebro-spinal system by section of the spinal roots supplying the tumor, the growth was less rapid (epithelioma, tar cancer, produced in rabbits). Sectioning of the cerebral-spinal roots is in effect stimulation of the corresponding sympathetic nerves, confirming the *association of sympathetic stimulation with a retarding effect upon cancer growth.* It has also been observed that resection of the sympathetic system (with of course consequent removal of its stimuli) caused the opposite effect, namely, an earlier appearance and more rapid development of the tumor. The evidence therefore indicates that the *sympathetic nervous system has a great influence in controlling the growth of the cells,* especially tumor (cancer) cells, and that stimulation of this system retards cancer growth. This in effect also is the conclusion of Willy Meyer,[17] who states that in cancer patients there is an hereditary vagus and sympathetic unbalance with an over-activity of the vagus and an under-activity of the sympathetic, with a resulting vagotonia. This causes a disturbance of the endocrine glands with a reduced parathyroid function, with a relative increase of potassium. Pottenger[21] widely extends this action and also includes the cells themselves, for he writes:

Vagotonia is a condition not of the nerves alone, but also of the cells acted upon; a condition in which the ion content of the cell is disturbed and the permeability of the cell membrane increased and in which the most evident change consists in a relative overbalancing of the potassium-calcium equilibrium in favor of potassium, so that a reaction on the parts of the cells, at least when stimulated by the parasympathetic nerves, results in action which is beyond the bounds of physiological reactions.

If the foregoing conclusions are true, and this depends upon the accuracy of the observations of those whom I have quoted, it may be concluded that drugs or other measures which excite the sympathetic system to activity or accentuate the reactions of an already functionally active system would be useful in controlling the cell growth of cancer tissue. From the work of many observers, we are impressed with the evidence that calcium has a profound influence on the reactions of nerve tissues, and it has also been noted that a high *ratio of calcium to potassium gives a sympathetic reaction.* A low calcium and a high potassium *give a vagotonic reaction.*[27] Definite evidence, comfirmative of these conclusions, is supplied by Kylin,[14] Pottenger[21] and Straub,[26] who states that calcium stimulates the sympathetic system and acts like adrenalin. E. Barath[2] holds that after the administration of calcium there is a short period of vagus stimulation and then a prolonged sympathetic stimulation with rise of blood pressure and of blood sugar. The last reaction was confirmed by other observers. Therefore it may *possibly* be concluded that increase of calcium in the blood beyond the normal ratio does stimulate the sympathetic system and indirectly inhibits the excessive growth of cells. This reduction in the growth activity reduces the size of the cancer mass, relieves the pressure on the terminal fibrils and lessens pain.

Calcium also acts directly upon sensory receptors and thus reduces pain. This direct action of calcium on the sensory reception

of pernicious stimuli and its effect in diminishing the receptivity of the pain-producing impulses in cancer has been confirmed, in a general way, by experimental evidence. It has been found that increased calcium content of the blood diminishes the electrical excitability of the nerves of the vegetative nervous system (L. Berman[5]). These findings have been confirmed by Chiari and Frolich.[7] By this inhibitory action upon the receptivity of sensory impulses, calcium increases the threshold for sensory (pain) stimuli so that they are with difficulty registered upon the receptors.

After pain stimuli are received by the sensory nerve terminal, they still may be obtunded by the direct action of calcium upon the conductivity of the nerves themselves. So that, even though stimuli do pass over the threshold for pain reception they may not (because of reduced nerve conductivity) be carried to the pain perception centers in the cerebrum.

The generalized reactions of calcium upon different component parts of the nervous system are demonstrated by the potency of calcium to relieve the pain due to lesions other than those produced by cancer, such as the headache following lumbar intraspinal anesthesia, also the pain due to brachial-plexus neuralgia. Calcium in the form of the chloride (20 c.c. of 5 per cent solution) given intravenously also relieves the pain of lead colic. Indeed the relief is so prompt and immediate that Bauer, Salter and Aub[3] hold that when pain in a patient apparently suffering from lead toxemia is not relieved by calcium, the diagnosis of lead colic is incorrect.

In 6 cases of gallstone colic the pain also was relieved, but in one case of cholecystitis the pain was not benefited. Calcium is also effective in relieving pain due to stone in ureteral colic. In twelve cases so treated by Bauer *et al.* some relief was obtained.

As stated calcium may act directly on the pain perception centers in the brain. Its sedative action is well known in continued nerve irritations such as hysteria and the like.

The action of calcium upon the central nervous system was carefully studied by Demole.[9] He found that direct application of calcium to the brain stem produced sleep. It has also been observed by many clinicians that patients to whom calcium has been administered go to sleep more readily than do those who have not received calcium.

Von Ploetta found that in *narcosis*, there is an *increase of calcium* in the brain and a corresponding decrease in the blood calcium. Such a distribution would explain the discrepancies between our conclusions and the findings of Glasser.

In narcosis the calcium content of the blood decreases and this change was also noted in animals in which the cortex of the brain had been removed. It has also been found that the potassium-calcium balance is regulated by a definite portion of the midbrain.

It may therefore be concluded that calcium has an action on the perceptive centers of the central nervous system, so that irritative impulses are less acutely perceived and it may be reasonable to suppose that this action aids in decreasing the pain perception in cancer.

In addition to calcium given by mouth, intramuscularly or intravenously in the form of the gluconate, calcium may also be given by mouth in the form of the lactate; J. H. Rose, and Bernard Kahn[23] were of the opinion that the calcium ions can be absorbed into the blood from the intestines; this was also the opinion of Gamble, Blackfan and Hamilton.[10] It should not be forgotten that vitamin D as found in cod-liver oil, viosterol, etc. is a potent agent in the mobilization of calcium in the system. For this reason vitamin D in any of the effective forms in which it is on the market should be given to the cancer patient.

Change in the calcium metabolism is also produced by *ultraviolet irradiation*. The increase of the serum calcium in the blood following ultraviolet irradiation may explain the beneficial effect of this type of

irradiation on pain and is in consonance with H. Humphries'[13] conclusion that "it would appear that the ultraviolet ray exerts some biologic action in the vicinity of irradiated interepithelial nerve fibrils."

Extract of parathyroid gland will also increase the calcium content of the blood and at the same time decrease the electrical excitability of the nerves (Berman, L.[5]).

It is also known that the parathyroid extract most markedly increases the ion diffusible calcium in those in whom this form of the element is low.

Parathyroid extract was used by the writer for a time in the form of the parathyroid hormone, which had been standardized.

However, it was observed that parathyroid when given to a patient increased the serum calcium at the expense of the calcium which was present in the bones, and most enlightening was the observation that the only patients in whom I found bone metastases developing, while they were under calcium treatment, were those to whom parathyroid extract had been given. An association between reduced calcium content of the bone and bone metastases seemed to be definitely indicated; therefore, we discontinued the giving of parathyroid extract to cancer patients.

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SURVEY OF SOME RECENT INVESTIGATIONS IN CANCER RESEARCH

THEORETICAL BASIS FOR THE ACIDOTIC TREATMENT OF NEOPLASIA*

ANNA GOLDFEDER, DR. SC., M.U.C.

NEW YORK CITY

IF one is to consider malignant tumors purely from the histological standpoint not much may be said, for the neoplastic cells have no specific form although the majority are larger than normal cells and show changes in the nuclear structure such as increase in chromatin substance, changes in mitotic forms, and asymmetry of the mitotic figure. The histological picture presents only the fully developed status of the condition.

From the biological viewpoint the tumor cell possesses enormous powers of growth and has a short life. Growth is, as we know, a function of the cell. If from the physico-biological standpoint we try to conceive growth and metabolism we must think in terms of chemistry. In the past, changes in the protein metabolism were considered characteristic of neoplastic cells but these changes have assumed a less important role since the energy producing reactions of the tumor cell have been more thoroughly studied.

We now possess a fairly thorough knowledge of the energy-producing processes associated with carbohydrate metabolism. All ingested carbohydrates ultimately appear as the end products, CO_2 and water, which are excreted. In certain of its phases the transformation of carbohydrates proceeds in a definitely disintegrating manner. Glycogen is ingested and its decomposition proceeds to the stage of lactic acid. If one compares the structural formulae of sugar and lactic acid it is seen that two molecules of lactic acid form one molecule of grape sugar. Expressed in other words, the decomposition of glycogen to lactic acid occurs without oxygen. Based upon the definition of Pasteur we may say that the production of lactic acid from glycogen belongs to a group of biological processes which produce energy without the presence of oxygen. A portion of the lactic acid with the addition of oxygen is reduced to CO_2 and water, the remainder being used again in the synthesis of glycogen (Embden and others). If we view the problem of neoplasia from the standpoint of metabolism certain questions arise. Is there a difference in the metabolism of rapidly growing malignant tissue, and more slowly growing benign tissue? In what manner do anabolism and katabolism occur? Where does the energy come from that produces the great growth power of the malignant cell?

In considering the carbohydrate metabolism of the malignant cell we are confronted first with the classical work of Warburg and his coworkers.[1] It is best at this point to consider first the older as well as the more recent investigations in this field. We know that the malignant cell differs in certain manners from the normal in its chemical and ferment processes, that the carbohydrate metabolism and respiration mechanism are different. Let us consider the chief points brought out by the work of Warburg and his collaborators. In its metabolism the tumor cell resembles the yeast cell. The tumor cell is able to produce glycolysis of glucose with the production of lactic acid. With

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one molecule of oxygen, malignant tissue produces from three to four times as much lactic acid as does benign tissue. The tumor cell is a facultative anaerobe and aerobe. Warburg[2] in his recent studies found that in every normal cell disturbance of respiration was followed by aerobic glycolysis. However with aerobic glycolysis benign cells die while malignant cell not only survive but continue to grow on the chemical power liberated. Aerobic glycolysis of the tumor cells undoubtedly arises because of disturbances in respiration.

Based upon the work of Warburg, I sought a biochemical explanation of the oxidation processes of katabolism in the organism. Warburg and others had already shown that the lack of oxygen in malignant tissue and the changes in carbohydrate metabolism thereby aroused were the cause of the increased production of lactic acid. That the carbohydrate metabolism plays an important role in those suffering from cancer is shown by the fact that diabetics who have cancer rapidly lose the excess sugar in the blood, which changes do not occur with other wasting diseases such as tuberculosis.

In my experiments three tumor strains were studied, the Rous chicken sarcoma, the Ehrlich mouse carcinoma, and the Ehrlich mouse sarcoma. The investigations were planned to answer the following: If tumor tissue is capable of glycolyzing lactic acid what is the fate of the glycogen? Various phases of tumor growth from first development through to final degeneration and necrosis were considered in the studies. The glycogen content was determined quantitatively in the various stages of the life history of the tumor and compared with the glycogen content of normal tissues in the same animal. The ability of malignant tissue to store glycogen as a reserve was also investigated and finally the influence of glucose upon tumor growth was observed.

The various reports of the glycogen content of malignant tissue, as recorded in the literature, are at variance. My investigations were done with a purely analytical method which need not be described, since this has been done elsewhere.[3] Briefly presented, the results showed that the amount of glycogen in the tumor and in the liver of tumor-bearing animals is less than the amount found in analogous tissues of non-tumor-bearing animals. Glycogen was always present in tumor tissue but in a smaller amount than in normal tissue. Examination made of inoculated tumors at three stages, (a) when the transplant was just palpable, (b) when the tumor had grown large and, (c) when the tumor had become necrotic and the animal was evidently cachectic, showed that the amount of glycogen in the tumor decreased as the tumor increased in size and became necrotic. In tumor bearers the same changes occurred in the glycogen content of the liver, as the tumor grew and became necrotic the amount of glycogen in the liver decreased.

The disturbance of glycogen level in the liver may be explained on the basis that in the earlier stages of tumor development the body has a carbohydrate reserve and is still capable of glycogenic synthesis. When the tumor has reached its greatest development it either demands more energy from the organism or the organism is no longer able to synthesize the glycogen.

The investigations were repeated with Plymouth chickens inoculated with the Rous sarcoma. In these experiments, completely necrotic, partially necrotic, and infiltrating portions of the tumor were compared with normal muscle from the same chicken. It was again demonstrated that with the continued development and necrosis of the tumor the glycogen content of the malignant tissue decreased.

The second question had to do with the influence on tumor growth and on glycogen reserve of diets very rich in carbohydrate. The details of these experiments have been elsewhere recorded.[3] I concluded that the addition of large amounts of carbohydrate to the food intake stimulated

the growth and size of the tumor but did not increase the amount of glycogen deposited in the tumor. I would call attention to the fact that animals given a rich carbohydrate diet and inoculated with tumor died much more quickly than did the control animals. The animals injected with glucose showed an earlier development of the tumor and the tumor reached a larger size than it did in the control animals, evidence that the tumor can be influenced by local measures.

In further experiments chickens were fed for a long period on a diet very rich in carbohydrates and then inoculated with the Rous tumor. When compared with controls no differences in the time of appearance of the "takes" or in the percentage of "takes" could be established. From this one might conclude that the carbohydrate influences the growth of the tumor but has nothing to do with the development of the tumor.

To summarize: (1) Malignant tissue (Ehrlich mouse carcinoma and sarcoma, and Rous sarcoma) contains less glycogen than analogous healthy tissues. (2) The amount of glycogen decreases as the tumor develops and becomes necrotic. (3) The carbohydrates increase the growth energy of the tumor.

After the publication of the experiments just summarized other investigators recorded results which in one way or another confirmed my previous work. Haendel and Mallet[4] determined the glycogen content of the liver of rabbits subjected to tar painting and found that it had been decreased. They also found that the glycogen content of the tar painted skin was decreased as compared with the normal. These authors came to the conclusion that a high carbohydrate diet increased the intensity of the tar reaction. Borghi,[5] who determined the glycogen content of mouse carcinoma after the administration of glucose and insulin, found that the malignant cells did not take up and store any of the excess glucose. Roussy[6] who examined the Rous chicken sarcoma for glycogen using the technique for determination by histological methods, found that the tumor was poor in glycogen. The disappearance of glycogen in tumor tissue is attributable to the lack of oxygen. In the normal cell the destruction of glycogen proceeds to lactic acid and then to CO_2 and water, although muscle cells again synthesize the lactic acid to glycogen. This according to Meyerhof[7] is disturbed in the malignant cell.

The question arises as to whether the lactic acid found in malignant tissue takes its origin from glycogen. One might readily conclude that the lactic acid is derived from glycogen if one could exclude its formation from albumen, pseudoalbumen, or fatty acids. On this basis further investigations were conducted.

Theoretically it may be supposed that since malignant tissue contains less glycogen than analogous normal tissue, even this lessened amount will become less as the tumor grows and becomes more necrotic. If it is further supposed that the lactic acid present in malignant tissue is derived from the glycogen alone, then as the lactic acid increases the glycogen should proportionately decrease. Since up to the present time no method for the quantitative determination of lactic acid in the tissues has been developed, I decided to determine whether there were any progressive changes in the hydrogen ion concentration, since if more lactic acid were formed the acidity should increase.

Up to the present time there has not been any considerable amount of work done on the hydrogen ion of tumor tissue. Woglom[8] states that the pH of the tumor is almost at the neutral point, i.e. 7.0–7.1. In contrast, Briefly and Millet[9] give the pH of the tumor tissue as 6.8, i.e. acid, as do Harde,[10] Harde and Danysz-Michel,[11] Harde and Henri.[12] These later authors found the reaction of the tumor tissue to be 6.0 and considered their results explained by the work of Warburg and Negelein. Expressed in their own words: "La reaction du tissu

pathologique est nettement acide. Ce fait doit-il rapprocher les observations de Warburg et Negelein." Inasmuch as the method employed by the various investigations cited may be open to some criticism as to the technical accuracy of the methods employed, I determined to investigate the problem further, using the method described elsewhere.[21] The tissues employed were the same three tumor strains previously mentioned.

Using the mouse sarcoma I found that the pH of fine divided tumor material suspended in either neutral distilled water or in physiological saline solution was 7.45. If only finely divided tumor tissue was used the average reading for a group of animals was 7.7. Based upon these results it may be stated that the reaction of the Ehrlich mouse sarcoma is alkaline. With the increase in development and necrosis in the tumor the degree of alkalinity increased, reaching 7.9 in necrotic portions of the tumor. The muscle of tumor-bearing mice showed the same range in pH values as did the tumor. Muscle from normal animals showed pH values ranging between 6.9 and 7.0, i.e. almost neutral.

The influence of glucose upon the hydrogen ion concentration in carcinoma tissue was next investigated. If, to follow Warburg's work, additional lactic acid is formed from glucose, then the acidity of the tissue should increase when glucose is injected. I injected experimental animals, either intraperitoneally or into the tumor, with definite amounts of glucose. Two and one-half hours after the injection I determined the pH value in the neoplastic tissue. (As is well known, glucose is metabolized by the organism in two and a half hours.) I pursued the following routine: In every experiment two mice were inoculated with tumor on the same day. One animal was injected with glucose, the other served as control. The measurements of the pH values of the tumors were determined at practically the same instant in both animals. In comparing the results[21] it was found that the hydrogen ion concentration was slightly lower in the animals injected with glucose than in the controls. The reaction however remained alkaline. In further experiments I only succeeded in making the reaction of the tumor acid with a pH of from 6.7 to 6.8 when I repeatedly injected the specified dose of glucose at hourly intervals.

Further investigations were carried out with the Ehrlich mouse carcinoma and the Rous sarcoma. Other than to state that the hydrogen ion concentrations were found to be comparable with those just described no further mention need be made. With the chicken sarcoma the pH values were determined in three different parts of the tumor and at the same time in the healthy tissue of the same animal. This tumor was also found to be slightly alkaline, the pH range being 7.6 to 7.7. It was noted that the more necrotic the neoplastic tissue was the greater was the degree of alkalinity. This change was more definitely in evidence with the chicken tumor than with the mouse tumor. In comparison with the normal tissues of the chicken with a pH value of 7.5 the tumor tissue from the same animal averaged a hydrogen ion concentration of 6.8. In other words the reaction of the Rous sarcoma is definitely alkaline while the normal tissues of the chicken are acid. All three tumor strains examined showed a range of pH values of from 7.5 to 7.7.

As I have previously stated, the recorded observations as to the hydrogen ion concentration in tumor tissue differ from those which I have found. The explanation for these differences probably lies in the different methods employed by the various investigators. It is not my intention to discuss this point in detail at the present time. This difference in results obtained by myself as compared with those obtained by other workers led to a new viewpoint. If one follows out the work of Warburg the viewpoint reached is that the reaction of tumor tissue is acid. Harde[10] states that in his experience the optimum de-

velopment of the tumor and its greatest virulence occurs when the pH values range from 6 to 6.2. Accepting my results one arrives at the opposite conclusion, namely, that cancer tissue shows in all the phases of its growth an alkalinity and that with increased growth and necrosis the alkalinity is raised.

G. Joos[13] confirms my results in that he found a definitely alkaline reaction in the tumors of mice. He gives the average pH as 7.4. L. C. Maxwell and Fritz Bischoff[14] found in the tissues of 90 per cent of tumor rats an increased alkaline reaction with an average of 7.32 pH. Kobliha[15] in his work with the Rous chicken sarcoma found an increase in the pH values of the tissues and confirmed my experience in that he found the older the tumor the more alkaline the reaction. Flaszen and Wachtel,[16] as a result of their experiments, concluded that alkalinity had a beneficial effect upon the development of tumors. Raadt[17] came to the conclusion in his work that alkaline food produces a tendency to cancer development.

The hydrogen ion concentration of the blood in those suffering from cancer has been reported in many articles in the literature with results that are discordant. I do not intend to discuss this phase of the question at this time, reserving the topic to be considered in detail in a later paper.

With the demonstration that the physiological and biological processes of ferment activity in the living organism are very markedly influenced by changes in the hydrogen ion concentration, more and more attention has been paid to this phase in the last few years. Variations in hydrogen ion concentration also have a great influence on glycolysis; thus Warburg[18] and others have shown that with a pH ranging between 6 and 8, the glycolysis of cancer tissue decreases with increasing hydrogen ion concentration.

I believe therefore that for the development and origin of malignant tumors a certain degree of alkalinity and a disturbance of the carbohydrate metabolism is of great importance. The new theoretical development leads to a suggestion in the treatment of malignant tumors. This new therapy is directly against the alkalosis, an attempt being made, in various fashions, to reduce the alkalinity of the organism. The importance of alkalinity in malignant tumors is stressed by Fischer Wasels.[19] This author points out that alkalosis stimulates metabolism and that in an alkaline medium glycolysis, cell division and growth energy of the tumor are stimulated. Good therapeutic results both in animal and men are claimed following the administration of a gas mixture of CO_2 and oxygen. This gas mixture not only influences cellular respiration but also decreases the hydrogen ion concentration.

Reding[20] in his work, "The Influence of the Ion on Malignant Cell Division," considers that the humoral changes of the cancer bearer consist in part of a disturbance of the carbohydrate metabolism and a disturbance of the acid base equilibrium. He records beneficial effects after parathyroid administration which he claims reduces the hydrogen ion concentration from alkaline to neutral.

The therapeutic results of roentgen ray therapy in cancer have also been attributed to the fact that it changes the hydrogen ion concentration from alkaline towards the acid side.

As we know, the medium, in which all things in nature from the smallest to the largest organism are grown, plays a most important part in the question of life or death. The hydrogen ion concentration of this medium is now recognized as one of the most important factors controlling life, for only within a narrow range of pH values may the many different processes of life continue. If we consider a tumor as a peculiar growth which in all phases goes through the manifold processes of life we can then recognize the important part hydrogen ion concentration of the me-

dium in which the tumor lives must play.

I believe that it is permissible to theorize that a tumor takes its origin in one cell in which for one reason or another metabolism and cell division occur in an abnormal manner. Since, basically, neoplasms are at their onset local conditions, it is logical to suppose that at their onset there is no generalized change in the metabolism of the individual. The metabolic changes only develop in the later phases of tumor growth. One may assume therefore that the tumor in its full development with its abnormal metabolism may then influence the entire body.

I do not desire at this point to discuss the question as to whether alkalosis in cancer is primary or secondary, or whether the cause is in an hypothetical cancer virus or follows abnormal metabolism of tumor tissue. These points will be considered in later publications. That we are dealing with a local alkalosis in cancer is, I believe, fully substantiated by the many investigators who have been cited, and I have again determined in experiments recently repeated that alkalosis is present in the earliest stages of tumor development. Irrespective of whether alkalosis is a local or a general body change, it seems logical that an acidotic therapy should be used to reduce the alkalinity of the tumor. If one succeeds by any manipulation in shifting the tumor reaction more or less towards the acid side then it should be possible either to retard cancer growth or to cause the disappearance of the tumor. As with any other therapy individual differences must be considered. An exact dose must be found, the susceptibility of the individual and other factors must be considered. Since the operative and roentgen therapy of cancer is admittedly insufficient a chemical method of treatment might well be deliberated. As one can with certain chemical substances and chronic irritation change a normal to a cancer cell, so one may expect other substances to be discovered which will return the cancer cell to a normal.

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TRANSPLANTATION OF THE GLUTEUS MAXIMUS MUSCLE

(A PRELIMINARY REPORT)*

J. DEWEY BISGARD, M.D.

CHICAGO

THE disability resulting from the loss of gluteal muscle function and the frequency of its occurrence in the residuum of anterior poliomyelitis has inspired several plastic operations designed for the functional substitution or partial replacement of this important muscle group. In their endeavors to reestablish these functions of extension and abduction in the affected extremities Lange,[1] Ober,[2] Legg,[3] Hey Groves,[4] Yergason,[5] and Dickson[6] have utilized the sacrospinalis (erector spinae), the tensor fascia femoris, and the semitendinosus muscles by various ingenious plastic operations. These observers have reported relative functional improvement in their cases as manifested by an increased stability of the hip joint with greater certainty of gait (less limp) and increased endurance in walking.

The possibility of transplanting a portion of the gluteus maximus muscle from the normal uninvolved side to exert its muscle pull for partial replacement of the action of its paralyzed contralateral fellow and gluteus medius was considered, and its rationale and technical details verified and evolved by anatomical dissection. It was found that the muscle belly could be split longitudinally at the bifurcation of the inferior gluteal nerve and independent nerve and blood supplies preserved in both segments (the inferior and superior gluteal vessels providing dual circulatory channels). Thus, anatomically, it appeared that it was possible to leave undisturbed the distal one-half or one-third of the muscle to carry on its normal function and to transplant the remaining proximal portion through a subcutaneous tunnel over the sacrum for transmission of its action to its newly established insertion, the greater trochanter of the opposite side. This operation was done in two cases which presented suitable indications, but insufficient time has elapsed to permit a final evaluation of the functional results. However, in both instances palpation at the present time elicits contraction of the transplanted segments simultaneously with abduction of the extremities and in one, increased stability of the respective hip joint.

A supplementary report with end results will be published at a later date. At this time a brief description of the operative technique will be given.

OPERATIVE TECHNIQUE

With the patient in a prone position an incision is carried from 4 inches below the greater trochanter to the posterior inferior spine of the ilium of the normal (donor) side and the fascia overlying the gluteus maximus muscle is exposed by a wide subcutaneous dissection. The part of the muscular insertion which joins the tensor fascia lata is incised so as to include a strip of this fascia 4 or 5 inches in length. The muscle belly is then split and the proximal portion dissected up to its origin where the inferior gluteal nerve is identified. At this point great care is exercised to carry the further division of the muscle between the branches of this nerve to insure innervation of both segments. The transplant is then freed with small shavings of bone by an

* From the University of Chicago Department of Surgery, Division of Orthopedics.

osteotome from its iliac and part of its sacral origins. At this stage the transplant is quite free with the exception of its nerve is established between the two incisions. The free end of the transplant including its fascia lata prolongation is drawn

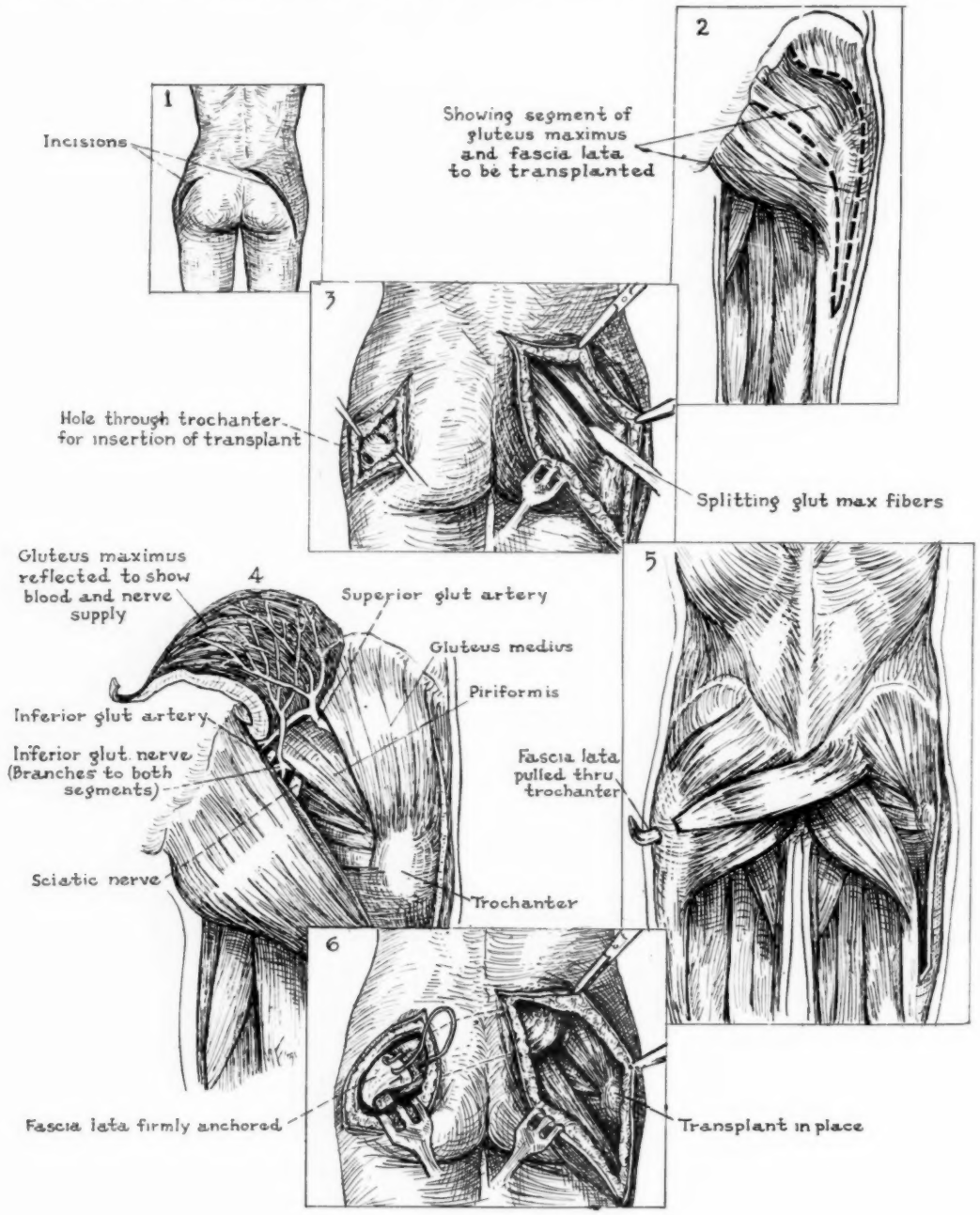

Fig. 1.

and vascular pedicles. The base (origin) is then rotated through an arc of 180° and re-attached to the sacrum by a few sutures of heavy silk. A small incision is made over the greater trochanter of the paralytic hip and a subcutaneous tunnel through this tunnel over the sacrum and is firmly anchored into the greater trochanter of the recipient extremity. This probably is best accomplished by passing the fascia through a drill hole in the trochanter.

[Concluded on p. 334.]

SPONTANEOUS RUPTURE OF THE UTERUS
IN PREGNANCY FOLLOWING A PREVIOUS CLASSIC CESAREAN SECTION*

P. D'ACIERNO, M.D.
UNION CITY, N. J.

SPONTANEOUS rupture of the uterus during pregnancy, though not mentioned by Harper[1] in his recent textbook, is more frequent than it is generally believed. Baisch[2] in 1903 collected 78 cases and noted that in 31 of them the rupture had occurred during the first five months of gestation. Instances of true spontaneous rupture, i.e., without a demonstrable cause, have been reported by Markoe,[3] McPherson,[4] Sieber,[5] Larrosa and San Martin,[6] Kreisch,[7] et al.; but in the vast majority of the cases there is either the history of a previous injury (perforation, rupture, etc.) or operation (curettage, manual removal of placenta, myomectomy, cesarean section, etc.), or the presence of previous infection with resultant chronic metritis, or of a congenital abnormality (hypoplastic uterus, uterus bicornis, etc.) or the occurrence of a definite anomalous or pathological condition (interstitial pregnancy, ablatio placentae, hydatid mole, chorioepithelioma, carcinoma of the uterus, etc.). At times the exciting cause of rupture of the uterus may be found in a diseased condition of the uterine muscle, as it happens in highly toxic patients. The general observation that two-thirds of the spontaneous ruptures occur among multiparae speaks for a deterioration of the uterine musculature after repeated pregnancies (Sachs[8]).

During the last two decades particularly, the profession has been aroused by the many cases of rupture which occur in pregnancies following cesarean section. In these cases the etiology is not always easy to determine. In some instances, the cause of the rupture may be imperfect healing of the incision, due either to defective technique or infection, or to the presence of a hematoma within the incision, or to inclusion of the decidua or serosa between the sutured uterine musculature, or postoperative adhesions of the uterus, or implantation of the placenta over the scar, or rarefaction of the uterine wall, due to atrophy of the decidua, and absence of the spongiosa, and a concomitant exaltation of the histolitic activity of the chorionic villi, as pointed out by Staemmler.[9] Other causes may be overdistention due to hydramnios, as in the case reported by Cleland,[10] or large fetus, or multiple pregnancy as in the cases reported by Woyer, Couvelaire, and Scheffzeck,[11] or the early recurrence of pregnancy after cesarean section, as in the case reported by Kosmak,[12] or forcible intrauterine manipulations, when performing a version and podalic extraction, especially in the presence of hypertonic condition of the uterus, or of Bandl's ring.

Furthermore Holland[13] states that in the rare instances in which cesarean patients come to autopsy, or if living, they are to be reopened for hemorrhage or sepsis, it is surprising how often one observes a yielding of the incision from loosening or cutting through of the sutures.

The object of this paper is to report a case of spontaneous rupture of the uterus, during pregnancy following a cesarean section, and to illustrate its pathogenesis, particularly on the basis of the histological findings.

CASE HISTORY

Mrs. V. H., No. 23855, aged thirty-one, gravida iii, family history essentially negative; had double pneumonia in childhood; menstruation at twelve, every twenty-eight days, duration five days, slightly painful.

Two years ago, after a long labor she was delivered of a live child weighing gms. 3237, by classic cesarean, the indication being a contracted pelvis. The operation was performed by a very competent obstetrician. No postoperative complications occurred, though the early puerperium was stormy.

She had a miscarriage since, at about two months of gestation.

*Read before the North Hudson Physicians Society, Dec. 28, 1931.

Her last menstruation started Nov. 15, 1930, and quickening was experienced about April 15, 1931. Throughout pregnancy nausea and vomiting were absent, and there was only slight edema of the right foot. About 11 P.M. July 16, 1931, the patient experienced intermittent irregular abdominal cramps, and strong fetal movements, which perhaps were the premonitory signs of the impending accident. Both of these symptoms lasted until the morning of the following day, when a doctor was summoned. He found the woman to be eight months pregnant, fetal heart tones a little to the right of the middle line, on the right lower quadrant, and on vaginal examination found the cervix uneffaced and closed, and no evidence of "show." Shortly afterward, the patient was seized with severe and continuous pains in the lower abdomen. These pains which were accompanied by sharp cries were of "stabbing type." At 10 A.M. the patient fell into a state of collapse; on reacting she was still suffering continuous and excruciating abdominal pains. She was transferred to the hospital at 12:30 P.M., when I was called into consultation.

On external examination a mass about the size of an eight months' pregnancy was palpated; small fetal parts could be distinctly felt in the mid-line, below the umbilicus. There was marked general tenderness, but no active contractions could be felt; no fetal heart sounds were heard. A diagnosis of ruptured uterus and dead fetus was made on the basis of the described symptoms and signs, and the patient was operated upon at once.

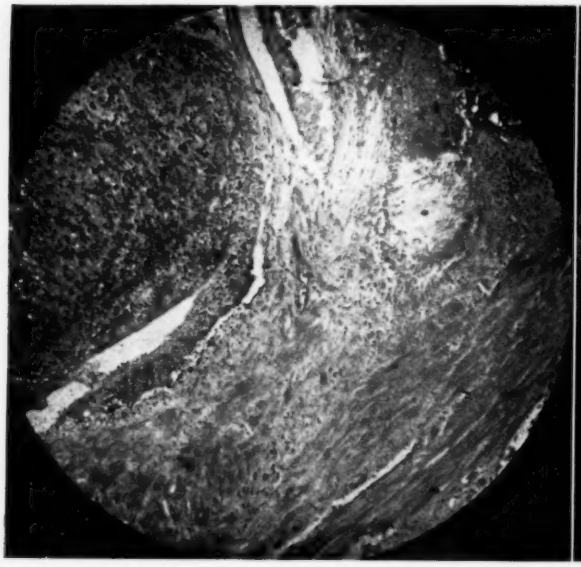

FIG. 1. Section at site of rupture, showing an increase of interstitial tissue amongst hypertrophied muscle cells.

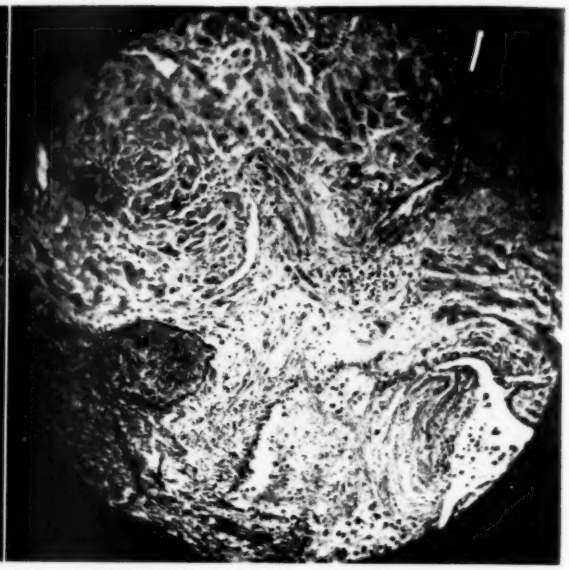

FIG. 2. Section through scar, showing two thrombosed blood vessels.

When the abdomen was opened, adhesions of the omentum to the uterine fundus were cut between two ligatures; the uterus was found ruptured along the entire scar of the previous cesarean section, a distance of 12 cm.; the amniotic sac, containing both feet, was still intact and partially protruding through the rent, where it was in direct contact with the peritoneum. The abdominal cavity contained a moderate quantity of blood and blood clots. After the sac was opened, an almost full-term dead fetus was delivered by breech, and the placenta, which was found already detached in the uterus, was easily extracted. The edges of the uterine rupture appeared discolored, were hard and callous, and covered with a fibrinous film. Wide débridement would have been necessary for closure, a procedure lengthening the time of operation, increasing the bleeding, and thus predisposing to infection, and rendering a future pregnancy obviously dangerous. Therefore, a supravaginal hysterectomy was performed, leaving the adnexa, since they were in a healthy condition.

Postoperative Course. Temperature was 102°F. the first day, when the patient received a transfusion of 500 c.c. of whole blood. The second day the temperature rose to 106°F., which probably was due to protein shock following the transfusion; third day: temperature dropped to 102°F.; fourth day: to 101°F.;

on the following three days it averaged 100°F.; from the seventh to the fourteenth day it was normal. There was no abdominal distention or dysuria. The pulse rate, which was 120 on admission, rose to 130 immediately following the operation, and then went down gradually to 120 the following day, to 110 next day, 100 on the third, 90 on the fourth, and 80 from the fifth day on, to the day of discharge. The wound healed by primary intention and the patient was discharged as cured on the fourteenth day postoperative.

A follow-up examination five months later showed a smooth and firm abdominal scar; no abdominal or pelvic symptoms or signs were elicited; the general condition of the patient was excellent.

Description of Specimen. 1. *Macroscopic:* The specimen consists of a uterus removed by supravaginal hysterectomy, which measures 15 cm. in length, 14 cm. in width, and 6 cm. in the anteroposterior diameter. The anterior surface presents a rent that measures 8 × 4 cm. which extends through the wall. The wall in this region measures about 2.5 cm. in thickness. On section, the cavity measures 7 cm. in length from the internal os to fundus, and 9.5 cm. in width. The inner surface is covered with fibrin and blood clot. The posterior wall measures about 3.5 cm. in thickness, and is soft and uniform. (The apparent discrepancy between these measurements and those found at the operation is undoubtedly due to the well-known fact that formaldehyde fixation causes a shrinkage of the tissue to almost two-thirds of the actual size.)

2. *Microscopic:* Section through the wall in the region of the perforation shows hemorrhage and an increase of interstitial tissue amongst hypertrophied muscle cells. The area of hemorrhage is narrow and does not extend deep into the wall (Fig. 1). Within the network of fibromuscular elements some thrombosed blood vessels are seen. There is no inflammatory reaction (Fig. 2).

Pathological Diagnosis: Ruptured uterus through scar tissue.

Postmortem findings on the fetus: Weight 3120 gm., length 50 cm. No abnormalities present; lungs: general atelectasis and edema. Cause of death was intra-uterine asphyxia.

COMMENTS

In reviewing this case two points are of special interest, namely, the type of the previous operation and the condition of the uterus, at the site of the rupture, that is, the gross and the microscopic appearance of the scar.

The first point, obtained from the obstetrical history of the patient, is that she had been delivered two years previously of a full term living child, by means of a classic cesarean section.

It is an incontrovertible fact that the classic type of cesarean section yields the largest number of uterine ruptures, which varies from 2–3 per cent, according to Schroeder, Couvelaire, Novak and Rongy, to 4 per cent as shown by Eardley Holland, and 5.6 per cent as calculated by Singer. In a recent article Phaneuf[14] reports 25 per cent of ruptures following the classic operation, as against 3 per cent following the low or cervical cesarean. Moreover, in some of the latter series only the contractile part of the uterus was involved, while the lower segment was found intact. In the cases, however, in which the operation was performed for placenta previa and eclampsia, these conditions no doubt contributed to the weakening and consequent rupture of the lower segment. Wetterwald[15] in a recent article arrived at similar conclusions. Again, as Greenhill and Bloom[16] point out, all of the few ruptures in the laparotrachelotomy series occurred in patients who had been in labor a long time and none occurred during pregnancy.

These findings, and the general observation that rupture of the uterus gives a maternal mortality of 50 per cent and a fetal of 90 per cent, fully explain the principal reason of the current trend of opinion, on the Continent as well as in this country, in favor of a more universal adoption of the lower segment transperitoneal cesarean. We should, however, remember that we do get ruptures following the latter type of operation (23 cases are on record in the literature). We do not as yet possess a method of determining the strength of a cesarean scar and its ability to withstand the distention inherent to a subsequent pregnancy or the strain of

labor. For this reason, we cannot accept Hirsch's[17] recent suggestion that cesarean section be adopted as the best operative method to lessen the high maternal mortality existing today.

The second point is brought out by the observation that the anterior uterine wall in correspondence of the cesarean scar was thinner than the posterior, a condition indicating that a process of atrophy had taken place along the line of suture, and, consequently, a "locus minoris resistentiae" had thus resulted. This is confirmed by the microscopical picture of the site of the perforation, which shows an increase of interstitial tissue, amongst hypertrophied muscle fibers. The further observation that the area of hemorrhage did not extend deep into the wall, and that a moderate process of thrombosis in the blood vessels of the uterus was present within the cicatrix, explains why the corresponding portion of the uterine wall had become almost bloodless and subject to a process of fibrous degeneration and atrophy. As this involves not only the muscles and the blood vessels, but the elastic fibers also, it means lessened distensibility of the uterus, and increased susceptibility to rupture. This view is in agreement with the most recent researches regarding the etiology and histology of rupture of the uterus (Ragonesi[18]).

In the light of these investigations it is apparent that the ideal union in a cesarean incision obtains where there is muscle regeneration, as shown by Williams.[19] Recent studies, however, show that the healing of smooth muscle wounds, in general, is brought about by scar tissue formation (MacCallum[20]). This observation is further substantiated by the fact that of the numerous reports about scars following classic cesarean sections, only nine deal with intact scars. Schwarz and Paddock[21] in their exhaustive histological study on "cesarean scar" conclude that muscle regeneration plays no important part in the healing of the scar, and consider fibroblastic proliferation as practically normal healing. Likewise Greenhill and Bloom[22] studying uterine scars in 37 cases, which had undergone a previous cervical cesarean section, found healing by scar tissue in 31, or 84 per cent. Commenting upon these latter findings, DeLee[23] states that, after all, perfect anatomic restoration of the cervix is not essential for the strain of subsequent labor, as proved by the very low incidence of rupture of uterus in labor following laparotrachelotomies.

The case reported presented almost all the classical symptoms of sudden rupture of the uterus; violent pains, internal hemorrhage, and rapid collapse. The pains were not intermittent as those of labor, but continuous and sharper. It is a well-known fact that if the accident occurs during labor, the pains cease immediately. There are, however, atypical cases in which the labor pains may persist despite rupture of the uterus, unless the fetus is in the peritoneal cavity. Heidler[24] reports 9 such cases.

The described train of symptoms may be completely absent in some cases, especially where the rupture occurs gradually. Schroeder, out of 63 cases, mentions 7 that were symptomless. Similar cases are reported by Ruder, Ischenhauser and von Dahl.[25] Kreisch cites a case in which both an eight months' fetus and the placenta had slipped through the rupture of the uterus into the abdominal cavity, but the condition was not recognized for twelve days, as there was comparatively little hemorrhage. Sepsis developed, but very slowly; the presumptive diagnosis had been cancer. This, as all other cases found in the literature, shows that laparotomy is the logical treatment of ruptured uterus. As a matter of fact, Petren[26] has shown from the tabulation of 754 cases of uterine ruptures, collected from the literature, that, by using conservative measures the maternal mortality was 73 per cent, while following laparotomy it was only 53 per cent, indeed it has been reduced within the last twenty-five years to 16 per cent, and even less when the laparotomy is done early (Riddel[27]). Naturally, during the operation the lacera-

tion is repaired in clean cases, when the rent is not very extensive, and its margins are not jagged, and when the mother has few or no children; on the other hand, in suspicious or infected cases, a supravaginal hysterectomy is performed, for, though this operation generally aggravates the shock, a great many patients may be saved, especially if intra-operative or postoperative infusions or blood transfusions are used to tide over a moribund patient; otherwise, if the mother survives, despite shock or hemorrhage, usually she dies of peritonitis. As regards the children, as we have already mentioned, the large majority die, though there are on record a few exceptional cases (Leopold, Davis, Henrotin[28]) in which, despite the rupture of the uterus and the passage into the peritoneal cavity of the fetus enveloped by its membranes, it survived, the gestation continuing up to almost full term.

In view of the foregoing considerations, all patients following a cesarean operation should be watched, especially during the latter months of pregnancy, and, if need be, hospitalized. A subsequent pregnancy should be discouraged for at least two years after a cesarean section. In a case of imminent or threatened uterine rupture the indication is to empty the uterus at once, methods which may increase intra-uterine tension, like version or high forceps, being avoided. In the presence of pelvic contraction or obstruction of the soft parts, a cesarean section, with excision of the old scar, is the operation of choice.

Among the many already mentioned factors of postcesarean rupture of the uterus, sepsis is undoubtedly the most important. An afebrile puerperium, however, does not give an absolute assurance of perfect wound healing. Other causes worthy of note are those relating to errors in operative technique, as placing the muscle-sutures either too close or too far apart, or using a very tight suture apt to produce pressure necrosis and a gaping defect in the wound, preventing primary union; or the inclusion of the decidua between the muscle edges, or uneven coaptation of the muscle layers, or incomplete retraction of the muscle fibers at the very time the uterine incision is sutured. In fact, as Holland[29] points out, anatomical studies both from reoperation and postmortem show that frequently the contractile muscle of the upper uterine segment pulls away from the incision, leaving only a bridge of peritoneum and endometrium.

In regard to suture material, Schwarz and Paddock[30] have found that in two clean uteri of patients who came to post-mortem five days after operation, there was a large amount of necrosis around the catgut sutures, while in a series of cesareanized guinea pigs, in which silk sutures had been used, there was little or no reaction. They came to the conclusion that catgut is by no means the best suture material. In this case, as in most instances reported in the literature, catgut had been employed. In this regard Holland has shown that with catgut the liability to rupture is two and a half times higher than with silk.

The type of suture also may have some bearing on the firmness of the scar. DeLee and Greenhill[31] maintain that wounds heal best when interrupted sutures are used.

SUMMARY AND CONCLUSIONS

1. Though no general conclusions may be drawn from a single case, nevertheless, it is advantageous to add this to the ever-increasing number of uterine ruptures following particularly the classic cesarean section, as it emphasizes the serious dangers which may follow this operative procedure, not only for the mother, but for the offspring as well. The lower segment section, albeit, in smaller proportion, is no exception.

2. The causes of post-cesarean rupture of the uterus are multiple, i.e., wound infection, type of operation, technique, suture material, postoperative adhesions, and in general, any cause interfering with the healing of the scar, by primary intention.

3. The histology of the cicatricial tissues sheds further light on the pathogenesis of scar rupture, showing that following a process of thrombosis of the blood vessels, and fibrous degeneration of the muscular and elastic fibers, a condition of atrophy results, which impairs the resistance, as well as the resiliency of the uterine wall, and with the increased ovular tension, finally resolves itself in a rupture.

4. In regard to prophylaxis, a subsequent pregnancy should be discouraged for at least two years after a cesarean operation, and all patients who have been sectioned should be watched during the latter months of pregnancy, and, if need be, hospitalized.

5. The consensus of opinion concerning the treatment of uterine rupture is in favor of laparotomy, because that is the best method of controlling hemorrhage, and if possible, of delivering a live child; if the wound is clean and not traumatized, if may be repaired, otherwise, a supravaginal hysterectomy is the method of choice. Palliative measures may be considered only in case of incomplete rupture or when hospitalization is not available.

6. As no type of cesarean affords absolute guarantee against the occurrence of a rupture, it is incumbent on every operator to weigh the indications and limitations, whenever a section is contemplated, to allow a complete test of labor in every case where there is no absolute dystocia, and to abstain from the operation in every instance, where the life of the mother, sooner or later, may be at stake.

I wish to acknowledge my indebtedness to Drs. W. Braunstein and A. V. St. George for their assistance in the preparation of the sections and the microphotographs.

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NEPHRECTOMY FOR INFECTED HYDRONEPHROSIS WITH BACTERIEMIA, MULTIPLE LUNG COMPLICATIONS AND FECAL FISTULA

REPORT OF A CASE WITH RECOVERY

LOUIS RENE KAUFMAN, M.D., F.A.C.S.

NEW YORK CITY

THIS case is reported for a number of reasons. While reports of hydronephrosis in children are fairly common, the history of this case shows, in a striking way, the liability of hydronephrosis to escape clinical recognition for a long period of time. It was suspected by Dr. St. John only on the finding of a sense of fullness in the left hypochondrium which led to intravenous pyelography.

The predominance of the Staphylococcus aureus demonstrated in the urine and pathology of the left kidney, in the blood stream, in the dental infection and strongly suspected in the pathology of the lung and pleura, is of considerable interest.

The association of pleural and pulmonary complications with a positive blood stream in renal infections is rather unusual.

Perforation of the intestine in association with nephrectomy either as an accident of operation or as part of the pathology present is certainly an unusual complication in renal infections. Recovery from this complication seemed, in this case, to occur with striking freedom from any serious hazard under the simple plan of saline cleansing from below and prompt arrest of associated fecal contamination and infection of the wound by Carrel-Dakin technique.

Attention is called to the fact that following recovery from the serious manifestations of staphylococcic infection, there seemed to be an increased sensitization so that the removal of the teeth and minor sinus infection precipitated an anaphylactic-like reaction.

In the consideration of the etiology, we were not able to demonstrate in the pyelogram nor at operation a satisfactory explanation for the hydronephrosis. The finding of Staphylococcus aureus on culture of the teeth is certainly suggestive of a possible etiological relationship from this source.

CASE REPORT

M. O'C., Aged eight, referred by Dr. Byron St. John, November 25, 1931.

Family History: Mother and father alive and well. Two sisters; two brothers alive and well. One brother died of pneumonia in infancy.

Past History: As child, had measles, pertussis and mumps and pneumonia at the age of three. Tonsillectomy 1926. The mother states that she never had rheumatism but in January, 1931 the school physician found, on examination, "rheumatic heart" and the family physician made a diagnosis of rheumatic myocarditis which, incidentally, we found to be present on admission, although there is no evidence that it at any time caused clinical symptoms.

History of Present Condition: For the last two or three years, at varying intervals, she has been subject to attacks lasting two or three days, of malaise, with vomiting and indefinite pain in the abdomen. At first, these attacks were attributed to simple indigestion. In 1930, the attacks became more severe, more frequent, and in the last three months have recurred almost every week. At present, the attacks are accompanied with definite pain in the left hypochrondrium and during the paroxysm the child lies perfectly still and is always relieved by heat and by massage at the side. Between the attacks she seems perfectly well. At no time has she presented symptoms of urinary disturbance.

Dr. St. John, during one of these attacks, found a palpable mass in the left hypochondrium and suspecting that the mass was renal

in origin made a study by means of intravenous pyelography. This demonstrated normal right kidney and a large hydronephrosis of the left

Fig. 1.

Fig. 2.

kidney and the child was referred for further study.

She entered the Flower Hospital on November 26, 1931 with a temperature of 104.2°F., pulse 156, respirations 36. The appearance of the child on admission showed slight pallor and an expression of pain. Heart: Definite hypertrophy; apex beat in sixth space, midclavicular line; sounds good quality; systolic murmur at apex, diffusely transmitted to the left, and at this time there was noted a definite area of pleurisy overlying a small area of apparent consolidation of the lower lobe of the left lung.

Abdominal Findings: Moderate distention with some rigidity of the oblique muscles of the left side; marked costovertebral tenderness of the left side; left kidney palpable, about twice the normal size, with extreme tenderness on deep respiration. As will be seen from the chart, the temperature on admission was elevated (104.2°F.).

Urinalysis on Admission: Specific gravity 10.10, cloudy. Reaction: alkaline. Albumin: .021%. Glucose: negative. Acetone: negative. Indican: negative. RBC: 1+. Pus cells: occasional clumps.

The blood count on admission is included in the chart of the blood examinations recorded throughout her hospital stay.

Blood Chemistry on Admission: Urea 19. Creatinin 1.87. Sugar 151. CO_2 52 per cent.

Routine nose and throat cultures on admission: K. L. negative: Staphylococcus aureus, pneumococci and streptococci. Vaginal smear negative for all organisms.

Cystoscopy: No. 20 bilateral catheterizing cystoscope readily introduced. Capacity 100 c.c.; contour of the bladder normal with a normal vascular arrangement. Both ureteral apertures are large; readily visualized. The efflux from the right was vigorous but no efflux was observed from the left. On the right side a No. 5 catheter was readily passed to the renal pelvis. On the left side, neither the olivary nor whistle-tipped No. 5 catheter could be advanced beyond 6 cm. from the aperture but

a No. 4 catheter was readily passed to the renal pelvis. Secretion from the left side was twice the amount recovered from the right and

FIG. 3.

the specimens were clear from both sides. Indigocarmine appeared from the right side in five minutes, reaching maximum concentration immediately, and the output as observed for a further twenty minutes showed normal excretion. It appeared from the left side in six minutes without evidence of concentration, with a much reduced output.

Cystoscopic Urine Reports:

	Bladder	Right	Left
Urea percentage....	1.8	2.2	1.0
Red blood cells.	Rare	Rare	Moderate number
Pus cells.....	Few	Occasional	Few
Epithelium..	Few squamous and rare cuboidal	Occas. squam.	Squam. & rare caudate
Casts.....	0	Few hyaline	Occas. hyaline
Culture.....	Staphylococcus aureus	Negative	Staphylococcus aureus

Pyelogram: A series of plates was made, the first with the injection of 20 c.c. of sodium iodide 15 per cent, followed five minutes later by the further injection of 15 c.c. without pain. There was dilatation of the pelvis to 5 × 7 cm.

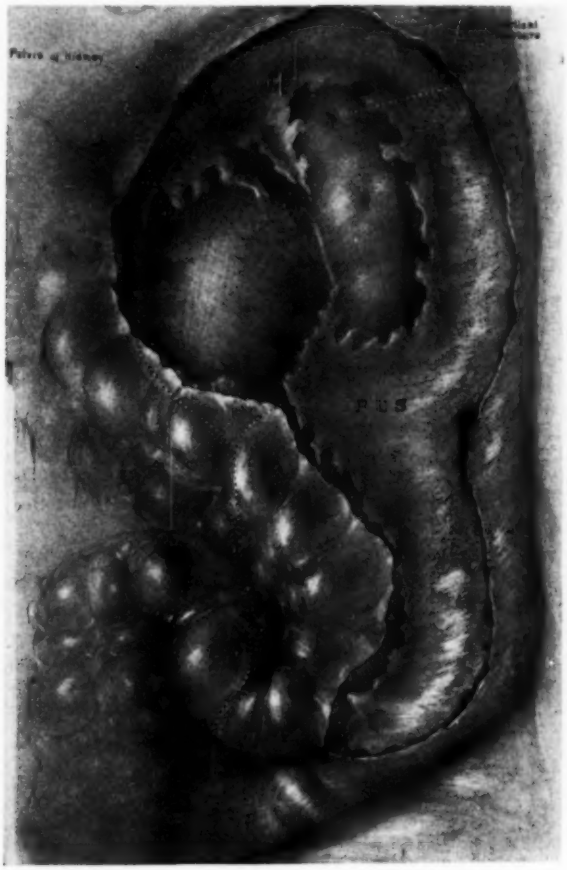

FIG. 4.

with marked dilatation of the calyces and thinning of the renal cortex; narrow ureteropelvic junction but without evidence of an obstructive factor anywhere in the course of the ureter. The two-hour plate showed retention which had disappeared in the twenty-four hour plate.

Clinical evidence of sepsis and the recovery of the Staphylococcus aureus in the urine led to blood culture and on December 1, the Staphylococcus aureus was recovered in pure culture, growing actively in two days. Four days later, an active growth was again recovered which showed definite hemolytic characteristics. Three days later, on December 18, growth occurred only after seven days' incubation and three days later, blood culture was negative and remained negative throughout.

In view of the left chest complication and the evidence of sepsis, operation was postponed and supporting treatment ordered including

colonic irrigations, clysis, digitalis, hexamethylamene and sodium benzoate, alternated with alkalis.

FIG. 5. Appearance of child December 30, 1931.

FIG. 6. Appearance of child February 18, 1932.

From the temperature chart it will be seen that the temperature fluctuated rather steadily with rapid respirations and a continuous high pulse, varying from 110–150 during this period. During this time, the cystic enlargement of the left kidney remained rather fixed with tenderness but no evidence of rigidity.

As soon as the medical consultant deemed it safe, with the improvement in the chest condition, operation was planned.

Operation: Dr. Kaufman; Drs. Wershub and Fisher, assistants; operative time: forty-five minutes; date: December 14, 1931. Anesthesia: Ethylene and oxygen, Dr. Donald E. Brace, and during operation, morphine sulphate, gr. 1/16, was given; 350 c.c. of saline intravenously were administered.

Left lumbar nephrectomy: Incision from junction of twelfth rib and erector spinae muscle extending downward, forward and inward about one inch above crest of ilium to outer third of Poupart's ligament. Immediately on section of the fascia, there was an escape of a large quantity of thick, offensive, yellow pus from the renal fossa. The peritoneum was pushed inward and during the dissection, the upper, inner aspect was entered; the rent about 2 inches long was immediately sutured with No. 0 chromic catgut. The perirenal fat was condensed into a thin sheaf, densely adherent to the peritoneum in front, and the kidney was much enlarged, dark red in color with at least two perforations through the cortex, each about 1 cm. in diameter, with necrotic edges. Offensive pus continued to ooze from the left iliac fossa during mobilization of the kidney. The pelvis was enormously dilated and solidly adherent to the abdominal wall and to the peritoneum and it was much thickened. The lower pocket of the abscess lay directly in contact with the posterior wall of the lowest portion of the colon and sigmoid, the surface of which was necrotic and dark red in color. The accessible portion of the renal pelvis was mobilized and included in the pedicle and transfixed for a distance of 3 cm. by a suture of No. 1 chromic catgut. Two additional ligatures were placed about the renal vessels below this ligature and the kidney removed without hemorrhage. A half-inch rubber tube was placed in the upper angle of the abscess cavity close to the pedicle and four strands of iodoform gauze were loosely packed into the pelvic portion. The wound was rapidly closed with No. 0 chromic gut and silk for the skin.

Postoperative shock required energetic stimulation with adrenalin, caffeine sodium benzoate, but within twenty-four hours, the condition of the child was satisfactory.

Fig. 7.

Pathological Report: (Dr. Alfred Angrist.) Specimen consists of a kidney, 12 × 5 × 3.5 cm. Its external surface is discolored reddish brown to pink and shows distinct lobulations. It is soft to pressure. A portion of the pelvis is present. The pelvic wall is thinned out and suggests marked dilatation. On sectioning the inner surface shows a granular reddish appearance and on section gives a gritty feel to the knife's edge, which is characteristic of fibrosis. On cross section the kidney shows a thinning out of the cortex which measures about 1.4 cm. The cortex in some areas shows a circumscribed yellowish zone which on closer examination resembles blood vessels with rather thickened walls. The cortex is pale and cloudy. The medullary portion measures about 4.4 cm. It is reddish and soft and friable showing multiple circumscribed zones of necrosis.

Microscopic sections of kidney show absence of kidney parenchyma and replacement of new-formed blood vessels in an edematous fibrillar connective tissue in which are many red blood cells, plasma cells, polynuclear cells and lymphocytes. Some of the fibrillar strands of connective tissue are composed of large elongated cells containing a swollen bluish granular fusiform nucleus characteristic of young fibroblasts. There is marked vascularization.

Another section shows a few tubules in a more cellular tissue. These tubules are lined by low cuboidal cells. The lumen contains a homogeneous pink staining mass and many cells with pyknotic nuclei.

Fig. 8. Appearance of scar February 18, 1932.

Other sections show new-formed blood vessels in the organized connective tissue and tubules containing necrotic cells and pink staining eosinophilic material. The tubules of the kidney parenchyma shows desquamation of the epithelial lining. The glomeruli have disappeared altogether or where seen are atrophied. The glomerular tuft shows hemorrhage and congestion with a large space between it and the capsule wall which is lined by a single layer of epithelium. There are focal areas of cellular infiltration with necrosis. Henle's loop shows desquamation of the flattened epithelial cells with a monocytic cell and an occasional lymphocyte in the lumen. The interstitial tissue is edematous and fibrillar and is diffusely infiltrated with monocytic cells. Large areas of necrosis are present.

A section immediately beneath the serosa shows a very faint eosinophilic staining vascularized connective tissue containing a moderate number of plasma cells, lymphocytes, and mononuclear cells. The muscularis has pink staining characteristics and other areas show degeneration with fainter staining material suggesting hyalinosis. Between the muscle bundles is a monocytic infiltration. The inner layer is markedly increased in thickness and is hemorrhagic and cellular with active fibro-

blastic proliferation. The cells are largely mononuclear. The epithelial lining is not seen and is placed by a granular monocytic exudate. Plasma cells are abundant. *Chronic Granulomatous and Productive Inflammation with Miliary Abscesses.* Note: No evidence of tuberculosis.

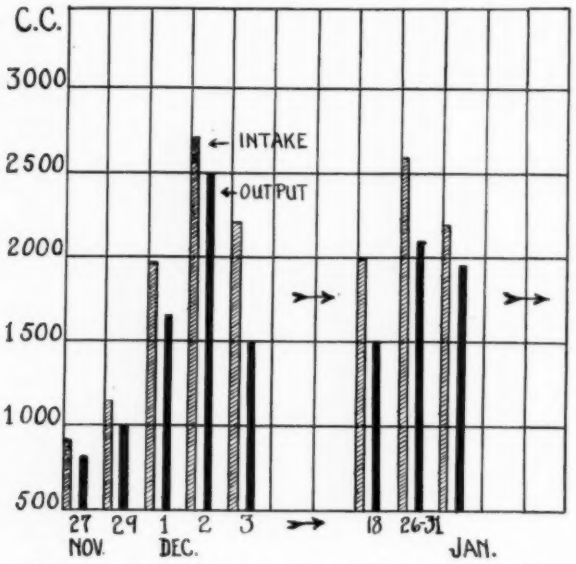

FIG. 9. Chart showing intake and output of fluid.

removed and the wound allowed to open through its entire extent.

In the management of the fecal fistula, free drainage was provided through the wound and sterile saline rectal flushes were given several times a day, the fluid returning through the lumbar sinus and so preventing retention of fecal matter in the large, sloughing wound cavity except during the brief period of the Carrel-Dakin treatment. At this time, five Dakin tubes were placed in the wound cavity into each of which 10 c.c. of 1 per cent chlorozene solution were instilled every two hours.

On December 18, all antiseptics were discontinued and from then on, moist boric acid dressings were continued until the wound had granulated and contracted. Following the closure of the fecal fistula, wound healing was rapid under Alpine lamp therapy and, as will be seen from the photographs, the final healing is practically the same as that following closure by suture.

Fecal drainage suddenly stopped on February 8, 1932, and rectal examination showed considerable impacted fecal material in the rectum, granular and sandy in character, the removal of which, followed by a cleansing enema, was followed by a profuse fecal drainage through the wound. For several days following this, there was abdominal distention, loss of appetite and vomiting with fecal discharge for

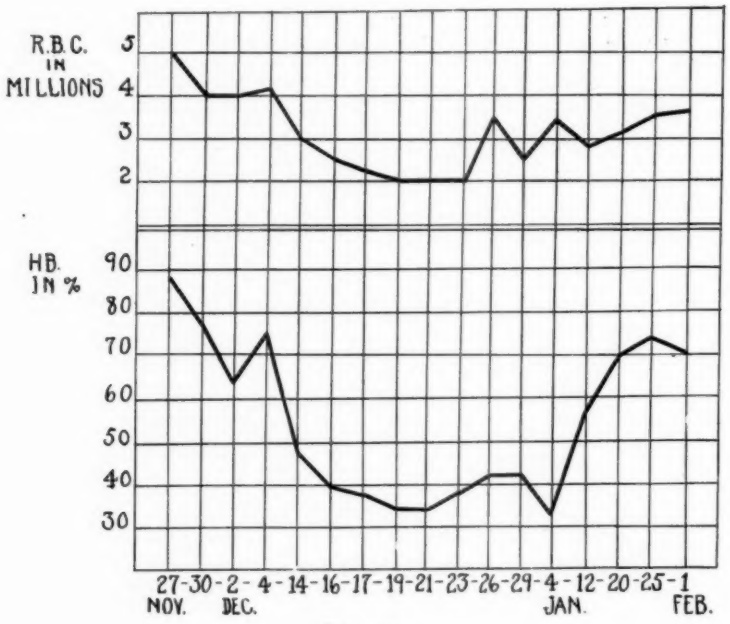

FIG. 10.

Postoperative Course: Discharge from the wound was abundant, at first bloody and purulent, and there was definite escape of fecal material on the third day; all sutures were

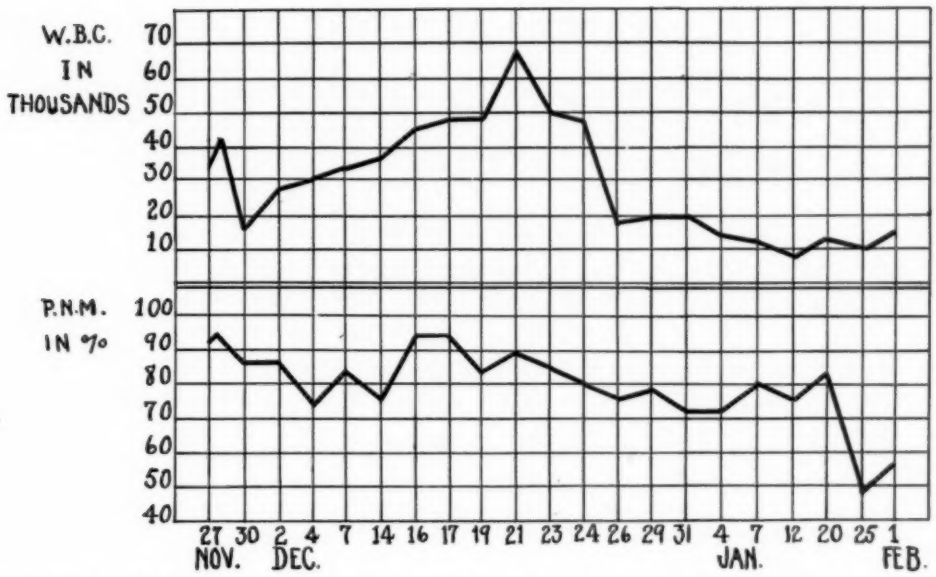

FIG. 11. In practically all of the estimations of the polymorphonuclear cells, the proportion of the immature and of the mature varied. For instance:

Date	Mature (per cent)	Immature (per cent)
11/27/31	52	40
11/30/31	67	20
12/4/31	57	17
12/21/31	46	44
12/31/31	58	14

Most of the early counts showed moderate poikilocites, slight anicytosis, slight polychromatophilia, few macrocytes, occasional microcytes.

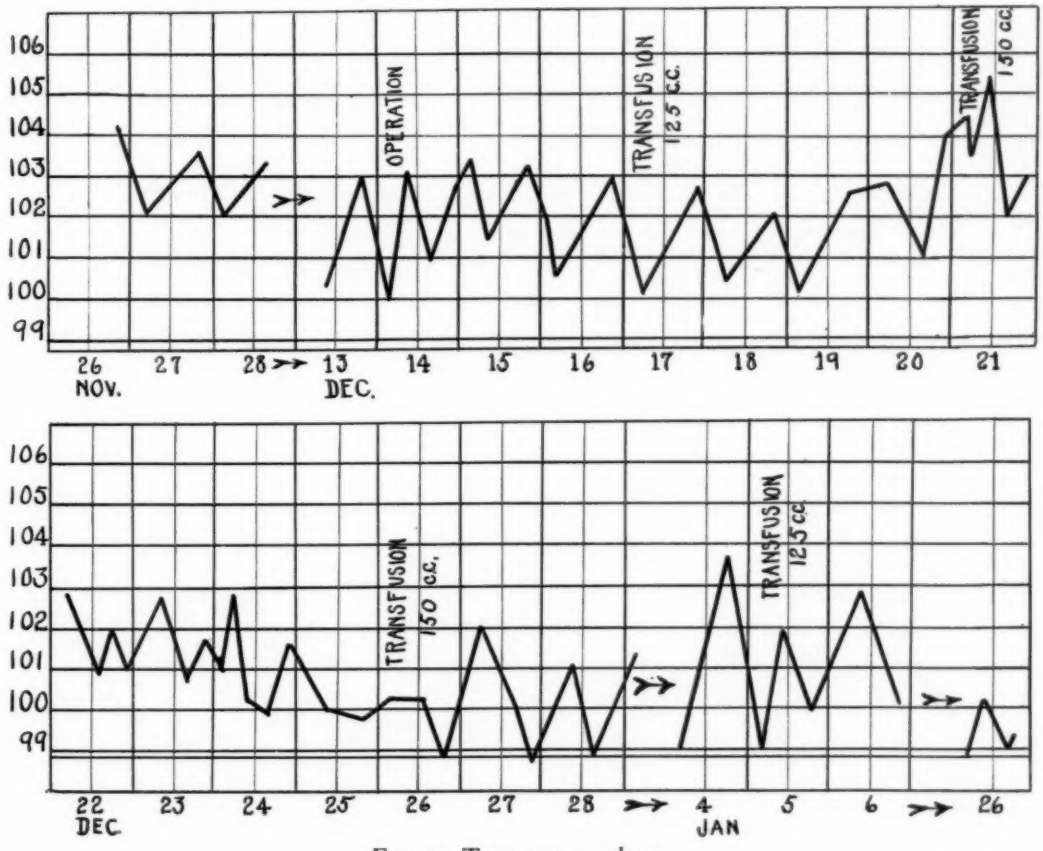

FIG. 12. Temperature chart.

three days. After this all fecal discharge ceased and there were no further gastrointestinal symptoms.

In the immediate postoperative course, the effusion of the left chest persisted for two weeks and within a week an area of consolidation developed in the right lower lobe shortly followed by a pleural effusion; this persisted throughout. Almost daily *x*-ray examinations were made which established peribronchial infiltration with increased density extending from the diaphragm over the apex of the right lung followed by an increased density extending from the right hilum horizontally out to the periphery of the lung; at this time, the left lung was clear.

Clinically, flatness was found over the right lower lobe extending to the mid-axillary line with hyper-resonance anteriorly and distant tubular respirations over the whole area and while on several occasions a small amount of fluid was demonstrated in the *x*-ray between the upper and middle lobes of the right lung, no definite pleural effusion was found nor was aspiration performed.

By the first of February, the chest showed merely a thickening of the pleura of the right lower lobe without fluid, with complete resolution in the pneumonic process with a disappearance of evidence of myocardial weakness.

Urine examinations showed a specific gravity varying from 10.08 to 10.24; albumin present as a trace, red blood cells occasional; pus cells 2+; occasional hyaline and granular casts.

In the general management of the child, it was felt that the main indication for treatment was the profound sepsis, not only the local manifestation of the wound area but as well in the bacteriemia present, together with metastatic infections in the chest

Renal function, fortunately, was competent at all times in the remaining kidney and there was no clinical or laboratory evidence of associated infection in the right kidney.

Recurrent gastrointestinal disturbance gave rise to much difficulty in feeding. The chart of the blood findings shows a drop of the red blood cells from the normal to a bare 2,000,000 and of the hemoglobin from 88 to 32 per cent with a more or less constant increase of the leucocytes. The peak of the leucocytosis was reached seven days postoperative, when the white blood cells were reported as showing 66,000 and the polymorphonuclear cells rose to 94 per cent.

Transfusions were administered by Dr. Fuchs who, in spite of the extreme severity of the blood stream infection in the case of a nephrectomized patient, administered four transfusions without the slightest reaction, the first on December 17, of 125 c.c. followed four, eight and twelve days later by three more transfusions of from 150 to 125 c.c. The small, repeated transfusions, we felt, were safer and this judgment was confirmed by the steady improvement which occurred following each.

It will be noticed from the intake and output chart (Fig. 9) that the relative balance was well maintained throughout the hospital stay.

A careful check-up examination on February 16 showed satisfactory healing with a rather wide but solid scar, without sensitiveness. Slight residual pleural thickening is noted in the right lower chest; heart sounds are of good quality; the child is up and about and eats well, with normal stools and there is no evidence indicating pathology at the site of the fecal fistula.

The urine shows a very faint trace of albumin with a specific gravity of 10.13; one red blood cell per field, with three pus cells only.

The blood count shows: Hemoglobin 85 per cent; color index 0.9; erythrocytes 4,430,000; leucocytes 12,050; neutrophiles 44; eosinophiles 2 per cent; basophiles 1 per cent; lymphocytes 50; mononuclears 3; poikilocytes occasional; macrocytes occasional; microcytes occasional; achromophilia slight.

The blood chemistry shows: Urea Nitrogen 12; creatinin 2; blood sugar 95.7.

X-ray examination of the teeth showed no gross pathology except cavities and three teeth were extracted. Culture of these teeth showed the presence of Staphylococcus aureus and a few gram positive bacilli. Following extraction of the teeth, there was an immediate sharp reaction characterized by the development of a diffuse erythema rash resembling a scarlet fever, a rise of temperature to 102°F. and within twenty-four hours swelling of the face and empyema of the right maxillary sinus. This rapidly subsided on appropriate nasal treatment.

At the time of this report, January, 1933, the child is in excellent general condition.

BENIGN AND MALIGNANT TUMORS OF THE KIDNEY

ASSOCIATED WITH RENAL TUBERCULOSIS*

J. M. MEREDITH, M.D.

PHILADELPHIA

THIS case, presenting a double lesion of the left kidney, seems worthy of report and recording. Both lesions, tuberculosis and pelvic neoplasm, were considered as probably present before operation. The patient, working in an experimental laboratory and handling a strain of avian tubercle bacilli, identified an acid-fast organism in his own urine, although subsequent investigations could not verify that his infection was other than the usual human variety. The primary pelvic growth, showing evidences of low-grade malignant change, has given rise to five metastatic growths further down the urinary tract, which growths are all apparently benign in character.

The patient, an adult Italian male, aged forty-three, was admitted to the University Hospital, service of Dr. Alexander Randall, on June 4, 1931, with a chief complaint of hematuria. The patient was quite well until two years ago when he had his first attack of hematuria which with all subsequent attacks, have always been painless. These attacks usually came on after violent exercise, such as tennis, which the patient played a great deal. There were no other outstanding symptoms; the patient is easily fatigued and has occasional headaches. His weight is 118 lb.; he has lost no weight recently. He states, however, that he has had several severe chest colds which brought on attacks of hematuria. He is a technician in a laboratory of experimental medical research.

Physical examination disclosed only the following: A healthy adult Italian male, almost edentulous. The chest was negative to inspection, palpation, percussion and ausculation. There was no adenopathy of the peripheral lymph nodes. Abdominal and rectal examinations were completely negative for any abnormalities with the exception of a questionable mass in the left costovertebral region. There was no tenderness over either kidney region.

FIG. 1. Urogram. Left pelvis shows a very definite deformity consisting of a marked clubbing of upper and middle calices and absence of lower calyx. There is definite dilatation and tortuosity of left ureter. A consistent filling defect is seen in all the films.

During his first stay in the hospital the following investigations were carried out:

Several examinations of the urine and sputum were negative for acid-fast organisms. *X*-ray examination of the chest was completely negative. B.U.N. 17 mg. per 100 c.c.; P.S.P. 65 per cent; B.W.R. negative; W.B.C. 11,900, Hb. 86 per cent.

Urography: The left pelvis showed a very definite deformity consisting of a marked

* From the Department of Urology, University of Pennsylvania. Presented before the Philadelphia Urological Society, January 25, 1932.

clubbing of the upper and middle calices and absence of the lower calyx. There was a marked dilatation and tortuosity of the left ureter, especially in its upper half suggestive of chronic infection. The pelvis was dilated and its shadow gave evidence of a definite filling defect. There being no hematuria at the time this was considered as probably due to a pelvic tumor. The roentgenologist stated: "We cannot definitely exclude a tumor of the left kidney pelvis but the possibility of tuberculosis seems to be more likely." (Fig. 1.)

The patient left the hospital four days after admission to be readmitted on June 22, 1931. Since his discharge, there had been only one attack of hematuria which had followed a game of baseball. He brought with him two slides of centrifuged urine sediment both of which showed acid-fast bacilli in great numbers.

Cystoscopy, on June 24, 1931, by Dr. Schofield showed no vesical pathologic change. Differential P.S.P. test (intravenous) gave an appearance time of four minutes from both ureters and, in fifteen minutes, 25 per cent from the right kidney and 8 per cent from the left. On June 26, 1931, a left nephrectomy was performed by Dr. Randall, the kidney being easily removed with 6 cm. of the ureter. On section, the entire pelvis was found filled with a papillary growth which had extended into the lower calyx. In addition, there were three caseous cavities in the parenchyma which contained pus and measured about 1.5 cm. in diameter. The histologic diagnosis was (a) papillary carcinoma of the pelvis, grade 1 (Fig. 2); (b) renal tuberculosis. Smears from the caseous material showed typical tubercle bacilli (Fig. 3).

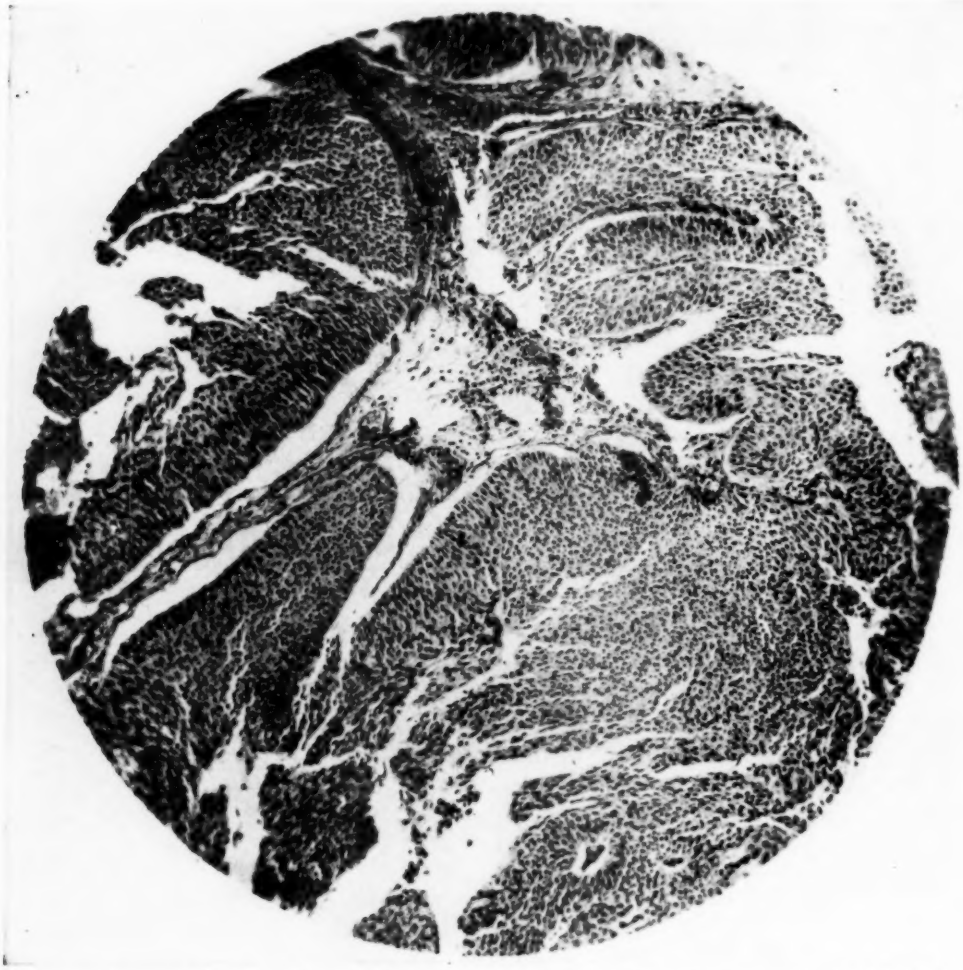

FIG. 2. Papillary carcinoma, Grade 1, of renal pelvis. Note diffuse sheet-like arrangement of epithelial cells with no limiting basement membrane (in lower half of figure). (× 92.)

It should be stated that the day before operation large numbers of acid-fast organisms were found in a twenty-four hour urine specimen. organisms in great numbers at necropsy whereas rabbits were scarcely affected at all in eight weeks established the organism as of

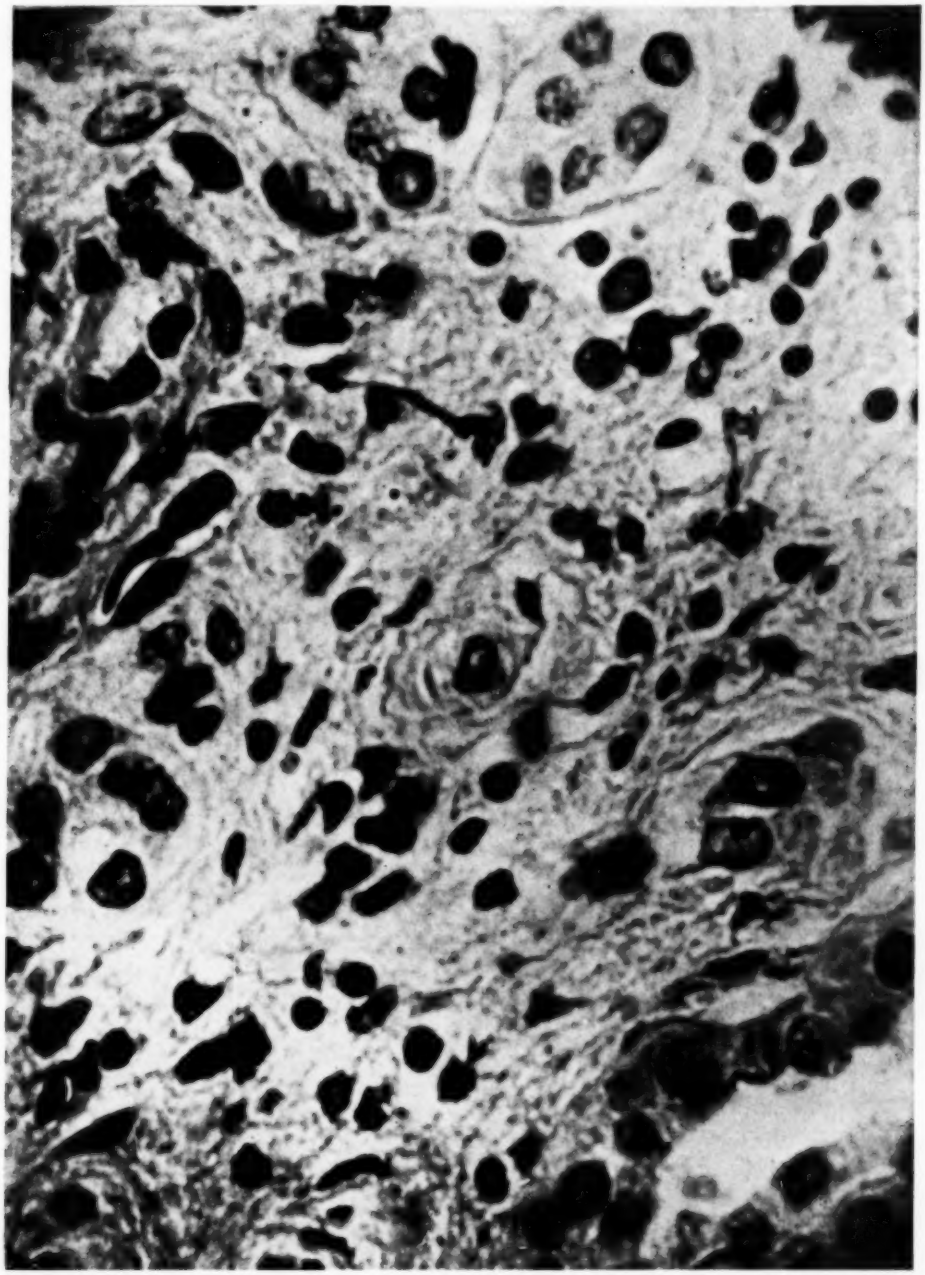

Fig. 3. Parenchymal kidney lesion showing chronic inflammation. Note infiltration of lymphocytes; there is an occasional polymorphonuclear cell, endothelial leucocytes and fibroblasts. No typical tubercles nor giant cells were found in sections cut. (× 917.)

The caseous material was submitted to the bacteriological laboratory for identification of organisms. From it, tubercle bacilli (hominis) were isolated by culture and animal inoculation. On potato, the culture was typical of the human strain and the fact that guinea pigs were killed in four weeks with recovery of the the human type.

The patient made an excellent recovery and was discharged on the eighteenth postoperative day.

The patient was re-admitted on November 28, 1931, again complaining of hematuria, with slight burning at the commencement of

urination. The nephrectomy scar in the left flank was well healed. The diagnosis was thought to lie between *right* renal tuberculosis,

A ureterogram, taken at this time (Fig. 5) was interpreted as metastic neoplasm in the stump of the left ureter.

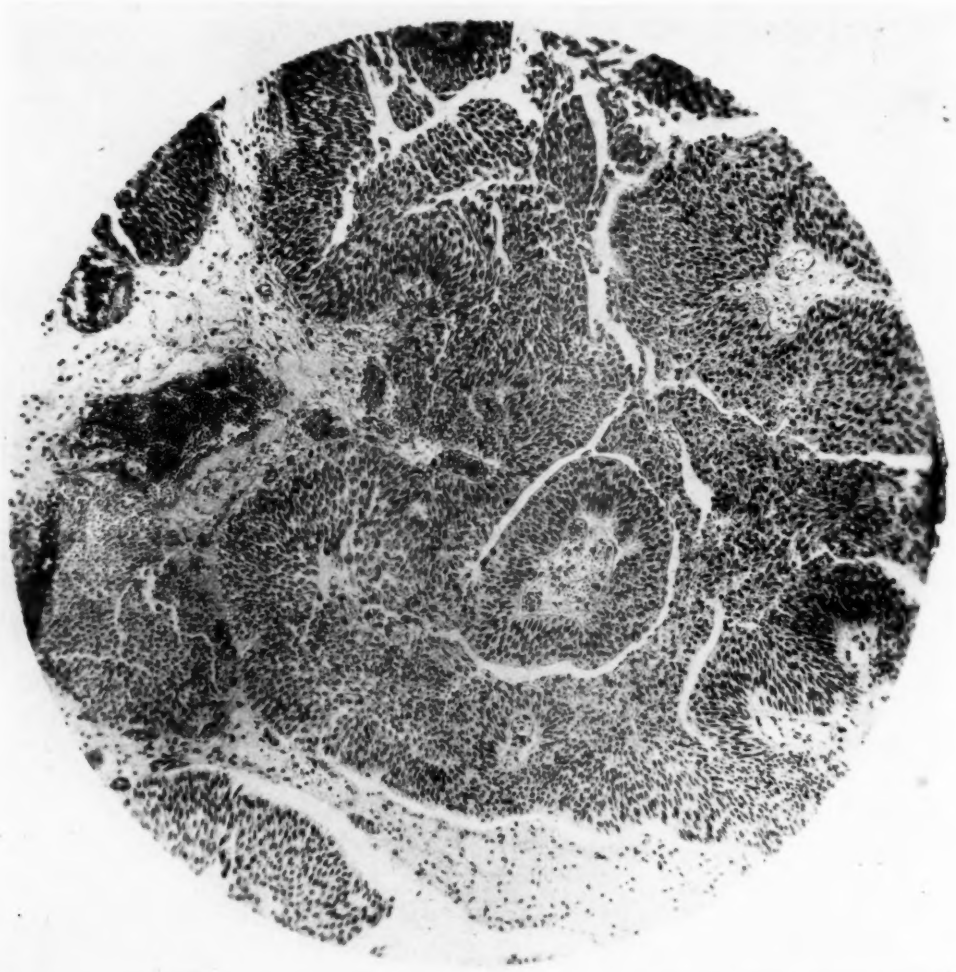

FIG. 4. Doubtful benign papilloma of bladder. This shows, in some areas, well-differentiated epithelium; in others, there is a definite lawless arrangement of cells with no limiting basement membrane. Note widely dilated capillaries giving tumor marked vascularity. (× 92.)

and recurrence of the malignancy in the ureteral stump on the *left* side. Three days after admission the patient developed hematuria and was cystoscoped immediately: Two papillomata were observed in the bladder proximal to the left ureteral meatus and the left ureteral orifice was emitting spurts of blood. The right ureteral orifice was normal. It was felt that there had been a metastasis of the neoplasm in the stump of the left ureter with metastases in the bladder.

The bladder papillomata were fulgurated under sacral anesthesia and biopsies were reported as benign papillomata. There is some difference of opinion on this. (Fig. 4.)

A left total ureterectomy was performed on December 9, 1931 under spinal anesthesia. The upper end of the ureter was markedly distended and bulbous, but showed no evidence of proliferation through the ureteral wall. When opened, the swelling was found to be due to a papillary tumor arising from a small pedicle attached to the ureteral wall, about 2 cm. below the point of ligation. Macroscopically, this had the appearance of a dense papillary growth, and it was felt that its solid consistency was due to compression more than to malignancy. Microscopically, the report was benign papilloma (Fig. 6).

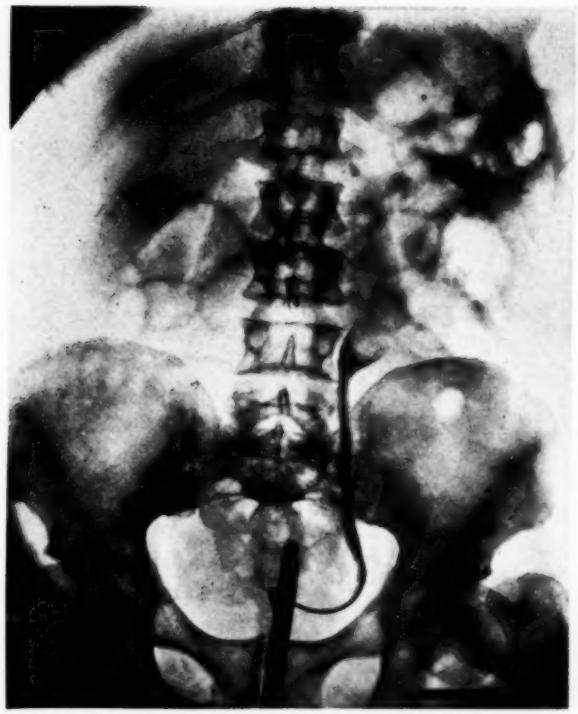

FIG. 5. Large dilatation and filling defect in upper end of ureteral stump, thought to be due to a recurrent neoplasm and so proved at second operation.

FIG. 6. Benign papilloma in ureteral stump. Note well-differentiated epithelium which is apparently not invading basement membrane. (× 92.)

The examination of six twenty-four hour urine specimens for acid-fast organisms, including guinea-pig inoculation, were all negative on this last admission. Apparently, the tuberculous focus had been only in the left kidney, removed five months before.

The last report in this case was on March 24, 1932 when the patient was cystoscoped by Dr. Randall and two benign papillomata were discovered in the vault of the bladder, each 5 × 6 mm. in size. They were easily and completely destroyed by cystoscopic fulguration.

SUMMARY AND CONCLUSIONS

We have here a case of hematuria for which a left nephrectomy was performed after appropriate studies had demonstrated a dual pathology in the left kidney. The organ contained a papillary carcinoma of the pelvis, Grade 1, together with parenchymatous tuberculous abscesses. Five months later, the patient returned with a recurrence of his hematuria at which time two benign papillomata were removed from the bladder wall by fulguration and a left total ureterectomy was performed for metastatic growth in the upper end of the ureteral stump. The papillomata removed from the bladder, as well as the one found in the ureter, and two further ones destroyed in the bladder, nine months after the original operation, were all reported as benign.

It is felt that the follow-up examination and time alone will eventually demonstrate the ultimate termination of this case.

NOTE: The writer wishes to express his indebtedness to Dr. Alexander Randall, Professor of Urology at the University of Pennsylvania, Dr. Karl Kornblum of the Department of Roentgenology and to Dr. Albert Bothe, Surgical Pathologist of the University Hospital whose aid and suggestions were of invaluable assistance in the preparation of this case report.

CONCLUSION OF DR. BISGARD'S ARTICLE*

If the large dead space on the donor side cannot be obliterated, drainage should be provided for a period of twenty-four to thirty-six hours. After closure of the wounds both extremities are immobilized in extreme abduction and external rotation in a double hip spica for four weeks. At the end of this time limited active motion may be permitted and muscle training exercises instituted.

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* Continued from p. 314.

HORSESHOE KIDNEY

CASE WITH FOUR PELVES AND URETERS; EXCISION OF HALF OF KIDNEY*

A. R. STEVENS, M.D., F.A.C.S.

NEW YORK CITY

REDUPLICATION of both pelves and the ureters in a horseshoe kidney is a rare finding. But my particular purpose in the following report is to call attention to an emergency procedure adopted in dealing with a mass of renal tissue after excision of a portion of the same.

CASE REPORT

The patient was a male, twenty-three years old, single, of Italian parentage but born in the United States. He entered Bellevue Hospital on March 30, 1931, with pain in the upper right quadrant of the abdomen.

One sister had died of tuberculosis, but the patient gave no evidence in history or in examination of any tuberculous involvement. He had had no serious illness and no operation. Gonorrhea and syphilis were denied.

Present Illness: During the past two years there had been 10 or 12 attacks of pain in the upper right abdomen, sometimes radiating to the testicle. Urinary frequency and hematuria were present with some of the attacks, but never between attacks. The patient had been in two hospitals without obtaining a diagnosis. Just prior to admission to Bellevue, he was seen at the Cornell Clinic where the true condition was recognized.

Examination: Routine examination, including the genital system, was quite negative. On abdominal examination the kidneys were not felt and nothing abnormal made out. The urine contained some pus and a few red blood cells. The Wassermann reaction was negative. N.P.N. of the blood was 32; creatinine, 1.4; phthalein output was 30 and 15 per cent for two hours.

Cystoscopy (April 1): Bladder mucosa was slightly inflamed; but no bleeding points, ulcers, tumors or foreign bodies were seen. Two ureteral orifices were noted on the left side and one on the right. All three were catheterized. A few pus cells were obtained from the right, none from either left catheter. Deep indigo-carmine and about the same percentage of urea were obtained from all. A plain *x*-ray film showed a shadow near the right fourth lumbar transverse process. Pyelograms (Fig. 1) demonstrated two dilated pelves on the left side, and one on the right embracing the shadow (presumably calculus). The latter proved to be the lower right pelvis; pyelograms (Fig. 2) made on another day showed the upper right pelvis, but not the lower one. But films made after uroselectan (Fig. 3) had been given intravenously demonstrated all four renal pelves.

Operation (April 8): Under spinal anesthesia, a low, oblique extraperitoneal, right kidney incision was made. The kidney was easily exposed, and it was necessary to remove the fat from the lower two-thirds only. The connection between the lower poles of the two kidneys was palpated and found to be about 2 by 1 cm. in thickness. The two ureters ran anterior to the renal tissue which crossed the mid-line, and were still unconnected as they went downward over the brim of the bony pelvis. They were accompanied by a large vein which sent branches to both renal pelves. The exact origin and disposition of the blood supply could not be determined without further, and unjustified, dissection. Palpation through an incision in the lower pelvis (on the anterior aspect of the kidney) proved that the calculus was in one of the lower calices. An attempt to remove it through the pelvis would have caused considerable trauma, hence an incision a little over 1 cm. long was made through the cortex, over the palpable stone, which was easily removed. There was moderate hemorrhage, easily controlled by one through-and-through mattress suture, each loop of which was placed over a bit of fat. Another suture in the capsule only brought the edges together. One suture was placed in the pelvis opening. Drainage was established and the wound closed in the usual manner.

* Presented before the Section on Genito-urinary Surgery, N. Y. Academy of Medicine, Nov. 18, 1931.

Postoperative Course: The temperature remained below 100°F., and all went well until the fifth day when hematuria was noted.

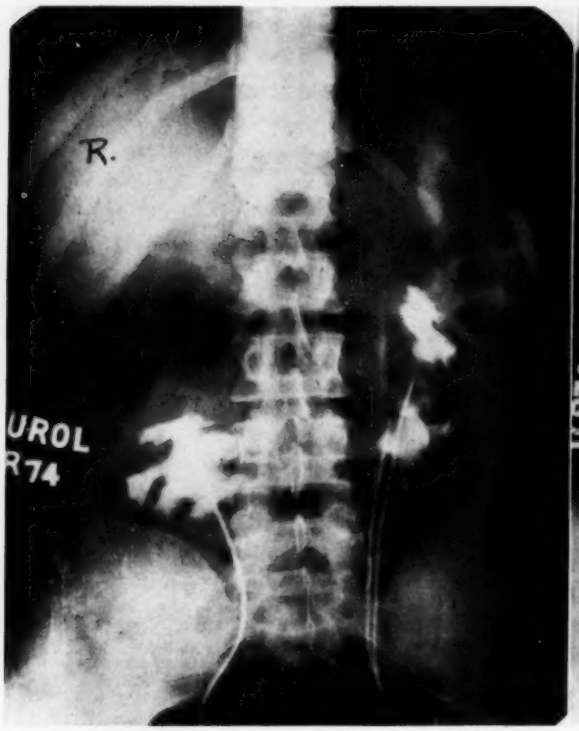

Fig. 1. Pyelogram showing lower right renal pelvis and both left renal pelves.

Fig. 2. Pyelogram at another time, showing upper right and upper left renal pelves.

Cystoscopy established the right kidney as the source of the blood. On the seventh day the urine was clear, but a little blood appeared in the wound. While I realized that these late hemorrhages usually mean infection and will probably demand surgery, I also appreciated the difficulty one might anticipate in any secondary operation in this case. Blood appeared and disappeared in an irregular manner, and each cessation would lead to the hope that the trouble was ended. Transfusions were given on the eighth and eleventh postoperative days. On the latter date, exploration was urgently indicated.

Operation (April 19): Under spinal anesthesia the old incision was reopened and a few clots encountered. An area 4 to 5 cm. in diameter about the old nephrotomy incision was covered with yellowish fibrin. The sutures in this incision were removed. The incision was not healed, but there was no bleeding point. It had been hoped that the lower half of the right kidney might be resected, but the kidney was fixed in position by adhesions and by arteries entering the two poles and moreover the patient's condition demanded a hurried operation. Hence both ureters of the right kidney were tied and cut, and all blood vessels entering the organ were quickly clamped, cut and tied. The thinned portion of renal substance joining the two kidneys could not be reached without more dissection and the risk of entering the peritoneal cavity. The anesthetist warned of marked rapidity and weakening of the pulse. Hence several sutures of heavy catgut were deliberately placed through the kidney with straight needles, as near the midline as feasible, and the tissue was tied en masse in several portions. The distal mass was cut away. During the latter part of the operation, glucose solution was given intravenously. Drains were placed in the wound but no sutures taken.

The pathologist's report was "suppurative nephritis."

Postoperative Course: There was no further bleeding. The general condition gradually, though slowly, improved. A third transfusion was given on April 26. The infected wound was frequently dressed and gradually cleaned up, and no further hemorrhage occurred. About two weeks after the second operation, several furuncles appeared on the body, and a large abscess over the right scapula required drain-

age. Hence the temperature did not reach normal until three and one-half weeks after operation. There was a small amount of urine discharged constantly from the wound, and it became increasingly evident that an operation to remove the remaining part of the right kidney would be required. The patient gained weight and strength steadily, and was given ample time to reach a satisfactory condition.

Operation (June 25): Finally, on account of constant urinary leakage from the wound, operative removal of the remainder of the right kidney was undertaken. Under spinal anesthesia, an incision was made through the lower part of the old scar and extended forward to the midline. The rectus muscle was first retracted inward, but finally cut across to obtain sufficient exposure. As the old extraperitoneal operative field was encased in tough scar, an intraperitoneal operation was decided upon. The peritoneum was opened and the intestines pushed aside with abdominal pads. The end of the kidney could just be palpated through the fat, and was exposed by opening the posterior layer of the peritoneum. A group of small vessels, presumably going to the cecum, were sacrified. By traction on the kidney stump, the narrow connecting portion was brought into the field. It was intended to cut across it between clamps and suture the left side of the incision. But the first clamp went through a soft and apparently infected area. Feeling that I must cut through the kidney tissue somewhat across the midline to stay well away from the infected portion, and realizing the difficulty of placing sutures here to control all bleeding, I decided to use the technique employed at the earlier operation. One suture was carried through the middle of the connecting portion of renal tissue with a needle, and the upper and lower portions each tied en masse. A small vessel entering the chunk of tissue to be excised was tied, and the mass easily removed. The posterior peritoneum was sutured, then the anterior layer. Retroperitoneal drainage was established, and the abdominal muscles and skin sutured as usual.

Fig. 3. Film exposed after uroselectan given intravenously, showing four renal pelves of horseshoe kidney.

The subsequent course was most satisfactory and the patient left the hospital in good condition, with a superficial granulating wound, without any pain or urinary symptoms, a month after his last operation. The urine contained a very small amount of pus; the blood chemistry was normal and the phenolsulphonphthalien output for two hours was 40 and 10 per cent.

CONGENITAL POLYCYSTIC KIDNEY

REPORT OF CASE*

JAMES DENTON, M.D.

BROOKLYN, N. Y.

I. L., a well-nourished and developed woman of twenty-four years, was admitted to the Brooklyn Hospital April 21, 1929.

FIG. 1. Appearance of abdominal cavity with kidneys in situ.

She was at term in her second pregnancy. On admission it was brought out that she had given birth after considerable difficulty two years previously to a full-term fetus with a greatly enlarged abdomen. It lived a few hours. The cause of the abdominal enlargement was thought by the physicians who attended her to be due either to bilateral tumors of the kidney or to polycystic disease of the kidneys. No autopsy was performed.

On April 23, after a somewhat prolonged labor, a female fetus at term was delivered by breech extraction. The extraction was somewhat difficult on account of pronounced enlargement of the fetal abdomen. After delivery, a large mass was palpable in either flank but it was normal in other respects. It lived about six hours.

FIG. 2. Cross section of right kidney showing small and imperfectly formed pelvis and spongy texture of renal parenchyma.

Autopsy, April 23: A female infant of average size at term. The abdomen is much enlarged.

Thorax: The organs of the thorax are displaced upward, the diaphragm rising three

* Read before the Section on Genito-Urinary Surgery, N. Y. Academy of Medicine, March 16, 1932.

ribs higher than usual; the thoracic organs are otherwise normal.

Abdomen: On opening the abdomen it was found almost completely filled by enormously enlarged kidneys. The combined weight of the kidneys was 450 gm. Each measured 10 × 6 × 5 cm. Between the kidneys there was a shallow groove in which the small intestine and part of the large intestine were located.

Liver: The liver was partially concealed by the enlarged kidneys but on removing it the shape and size were normal. It was of normal appearance on section.

Kidneys: On removing the kidneys, both ureters were found of normal size and shape and could readily be traced from the bladder to the renal hilus on each side. Both were patent. Both kidneys were rounded in shape. The pelves were scarcely visible externally, but receded into the renal hilus on each side. The pelves and ureters contained no urine. On section, both kidneys were found to be rounded, of spongy texture, with numberless irregularly shaped spaces filled with fluid. The spaces were not globular cysts but mainly tubular canals. The sponginess was perfectly uniform throughout both kidneys. The pelves were collapsed but patent and communicated properly with the ureters.

Bladder: The bladder was small and empty. The urethra was patent and of normal size.

Fig. 3. Section of renal cortex showing dilated secretory tubules and unexpanded glomeruli.

Histological Examination: Numerous sections were prepared from the cut surfaces of the kidneys after hardening. They all showed essentially the same condition: about nine-tenths of the renal tubules were dilated and filled with urine. Between the areas with dilated tubules, there were narrow wedge-shaped areas containing collapsed, cordlike tubules and small numbers of unexpanded glomeruli. The larger collecting tubules were filled with desquamated epithelium but contained no urine. Sections through the papillae showed no communication with the pelves. It was not possible to identify different portions of the tubules with any degree of accuracy on account of the marked distention. No dilated capsules of Bowman were observed. No glomeruli were seen which appeared to show any evidence of secretory activity.

Brief mention may be made here of the conclusions of several observers who have investigated the development of

cystic kidneys. Hildebrand[1] suggested that failure in union between the collecting tubules and the anlagen of the uniferous tubules was the cause of the formation of cysts in congenital cystic kidney. Ribbert[2] described the conditions in a newborn infant and was able to show that many of the cysts developed from Malpighian corpuscles which showed no connection with collecting tubules, the ends of which were cystically enlarged. Meyer[3] studied the case of an infant which lived nine weeks and found that in certain regions the renal parenchyma was normally developed while in others the portions of uriniferous tubules which normally connect the Malpighian corpuscles with the collecting tubules were represented only by an indifferentiated tissue rich in cellular elements and in which there were imperfectly developed tubules in the form of rings and cords.

These observations, together with the details observed in this case, are evidence to my mind of the correctness of the view held by numerous investigators (Huber[1]) that the collecting tubules and uriniferous tubules proper arise from separate anlagen. Since the primary units of the kidney develop in crops or broods, the relative degree of cyst formation and the duration of life in polycystic disease appear to depend upon the relative number of primary units in which the developmental imperfections occur.

Fig. 4. Section of medulla showing general condition of medullary portions of both kidneys.

[1] Hildebrand. *Arch. f. klin. Chir.*, 48: 361–363, 1894.
[2] Ribbert. *Arch. f. mikr. Anat.*, 17: 115, 1880.
[3] Meyer. *Munchen. med. Wchnschr.*, 50[1]: 770, 1903.

DISCUSSION

Dr. Edwin Beer: The polycystic kidney is particularly interesting as it is difficult to see how the tubules could be filled with urine if they were not connected up with the glomeruli, as the urinary secretion takes place in the

[1] Huber. *Am. J. Anat.*, 4, supplement p. 6, 1905.

glomeruli. In serial sections of such kidneys, one is liable to be convinced of the theory of Ribbert, to the effect that most of the cysts are glomerular in origin, and that the pathology is the result of non-union between glomerulus and tubule, in fact, in serial sections one often finds alongside of perfectly healthy glomeruli others which show atrophic glomerular structures, the glomeruli being pushed to one side of the wall of the cyst. In other cases the cyst wall shows no evidence of glomerulus structure. The impression one gets from this is that almost all the cysts are derived from Malpighian bodies in which the glomeruli are more or less completely destroyed.

Dr. Meredith F. Campbell: During the past year I have seen three infants during the first week of life with marked suppression amounting almost to an anuria and in whose abdomens could be palpated what might be taken to be congenital polycystic kidneys or congenital bilateral hydronephrosis. I saw one of these cases with Dr. Rathbun; I believe the child was cystoscoped. We found in these cases that by forcing large anounts of fluid (glucose-saline) normal urinary excretion is assumed, the child "fattens" up in a very short time, and the kidneys are no longer palpable. Urinalysis is negative. In such instances, the renal enlargement is relative as a result of dehydration and emaciation.

I was particularly interested in the statement made concerning the kidneys in Dr. Denton's case as a cause of dystocia; in obstetrical books it is mentioned, but no specific cases are cited. In Henry Morris' book on Renal Diseases he mentions a case in which evisceration of the fetus was necessary. I looked up this condition and learned that in twelve years there had not been such a case at Sloane Hospital and I could find no record of such an incident at the Nursery and Child's Hospital. In reviewing 2420 autopsies in children at Bellevue Hospital there was one case of small polycystic kidneys slightly larger than normal size, but none like that described by Dr. Denton.

Dr. Denton (*Closing*): I had much the same idea about the kidneys that Dr. Beer appears to have before I studied them. Although we did not cut serial sections of the whole kidney we did cut several short series and looked for dilated glomeruli and cysts containing glomeruli, but found none. The wedge-shaped areas of essentially normal kidney scattered through the cut surface contain unexpanded, fetal type of glomeruli and give no evidence of secretory activity. I look upon these islets of renal units as later broods than the dilated units. Just what the fluid in the dilated units is I do not know, but assume that it is urine or something very similar to urine. There are no vestiges of glomeruli in the areas where the tubules are dilated. Where the tubules are dilated it is very difficult to identify the specific portions of the tubules except in the case of the larger collecting tubules. On gross examination the fluid in the cut surfaces of the kidneys was yellow and had all the appearances of urine.

THE SURGEON AND ANESTHESIA IN GOITER SURGERY*

FREDERICK S. WETHERELL, M.D., F.A.C.S.

SYRACUSE, N. Y.

A FEW years ago, one of the two surgeons who was doing the major part of goiter surgery in one of our large clinics was asked why it was that he used a gas anesthesia, which completely anesthetized his patient, rather than a combination of local with only a very superficial gas anesthesia, such as his confrere used. His answer was that he felt more at ease and worked with less nerve tension, when the patient was entirely oblivious to his surroundings. The patients of both these men seemed to have equally tranquil postoperative courses.

The explanation seems reasonable and brings us to the proposition that the type of anesthesia, which is safe for the patient and with which the surgeon is able to do his best work is the one which is best for the patient.

Many papers have been published by surgeons holding a brief for a certain type of preliminary sedative, followed by a certain definite type of anesthesia. Each writer is properly enthusiastic for his way of doing things. His results are good, his mortality rate is as low as it should be.

With all of the foregoing in mind, the writer, by a review of the literature, not by any means complete, for that would be almost out of the question in a contribution of this character, and by the results of a brief questionnaire sent to seventy-four surgeons in the United States and Canada, who are particularly interested in goiter surgery, has attempted to show the present trend in anesthesia and preliminary sedative. It may also be possible to arrive at some conclusions as to the most useful methods known today.

Stanton in 1927[1] evaluated the anesthetics used in surgery by 640 surgeons in the American College of Surgeons. These men were picked at random from the directory. In this group of answers was one under the sub-title: "Goitre Operations." Of this small percentage of the membership of the College, there were 570 who gave preferences of anesthesia in goiter work. In the 570 there were, undoubtedly, some who used more than one type of anesthesia. This is evidenced by the fact that there are 658 answers from the 640, regarding anesthesia in laparotomies. If one were to multiply the number of men answering this questionnaire under the head of goiter surgery, by the proper figure, it would show an enormous number of men doing goiter surgery in this country. The figure may be correct. If it is, then the results of a questionnaire sent to men known to take a special interest in diseases of the thyroid gland, and surgery pertaining thereto, should be of particular interest to them, for according to Stanton's table 113 of these men use a "straight ether" anesthesia. It is interesting to note that not a single one of the answers to our query mentions ether, with one exception, and then it is used to supplement a basic anesthesia. In the answers received, no mention was made of spinal anesthesia. This method has been used. There are many contraindications, and the method is here mentioned only to condemn it. We are enthusiastic about spinal anesthesia in abdominal surgery, and prefer it to any other in that type of work. Any one who knows "spinal" and knows "goiter," knows that the two will never go together except with a very definite increase in dangerous complications.

After a careful analysis of the letters received, we have tabulated the results as shown in Tables I, II, and III.

[1] *Surg., Gync., Obst.*, 86: 273–277, 1927.

*Read before the American Association for the Study of Goiter, Kansas City, Mo., April 9, 1931.

In summarizing, and in our attempt to analyze the statements regarding preferences in anesthesia, and the reasons given for these preferences, we have tried to maintain a judicial attitude. The study, as heretofore mentioned, has been made with the hope that the most useful methods of anesthesia in thyroid surgery, as known today, may be brought to the attention of those particularly interested in this subject.

Table I

ANESTHETIC PREFERRED

General Gas Anesthesia	Combined, or Anoci-association	Local	Avertin $+N_2O$	Cervical Block
29	16	9	1	1

Second Choice of Those Who Mentioned One.							(Reason: "Bad Risk" or "Very Nervous")		
Local	Sod. amytal +chloretone	No second choice	Ethylene or avertin	Local	Avertin + local	$N_2O + O$	Anoci-association with ethylene	Ethylene	
5	1	20	1	2	1	1	1 General with gas 1	1	0

Table II

SEDATIVES GIVEN THE NIGHT BEFORE OPERATION
(Not all answered this)

A, Those employing general anesthesia.
B, Those employing combined anesthesia.
C, Those employing local anesthesia.

	Sodium Amytal or Amytal	Sodium luminal or luminal	Veronal	Nembutal	Barmidon	Chloral Hydrate
A.	19	5	1	1	1	1
B.	2	3	2	0	0	0
C.	2	0	0	0	0	0
Total	23	8	3	1	1	1

The details of the administration of anesthesia have not been considered, for we feel that this is a problem for the anesthetist. A survey of the literature published in *Current Researches in Analgesia and Anesthesia*, shows that, as a group, the anesthetists sense their responsibilities.

GENERAL GAS ANESTHESIA

It is apparent that a majority of the surgeons prefer general gas anesthesia. The number is a little over 50 per cent of all other methods combined. Of those employing general anesthesia a large number prefer ethylene. The important reasons given for a preference of ethylene are that the induction is rapid, and the patient may be brought out rapidly, and the ability to use a large percentage of oxygen, which is highly desirable in goiter patients. The danger of explosion is spoken of, yet many men use nothing else and have no trouble with it, because their anesthetists are using modern apparatus, built with the idea of eliminating the explosive dangers. (Our anesthetists have used it for six years in all types of surgery, with no explosion.)

Those who use nitrous oxide and oxygen favor it mainly because of its low toxic effect, and because they believe that it is less irritating to the respiratory passages than is ethylene. Those who use nitrous oxide have used it for years, and they have expert anesthetists, who are thoroughly trained in its administration. The dangers of anoxemia with an inexpert administration of nitrous oxide are mentioned. The importance of employing an anesthetist who is well grounded in the details of anesthesia as applied to thyroid surgery is stressed repeatedly. The team work

that ensues is felt by many to be a large factor in insuring a careful, uninterrupted operative technique. The facility with which the operation is performed under gas anesthesia is reiterated throughout the remarks.

anesthetist to bring him out after the first lobe is removed. Most men feel that it is a good safety measure to have the patient talk after removal of the first lobe. Gas anesthesia, it appears, may be practically omitted after the first lobe is removed;

TABLE III

SEDATIVES USED JUST BEFORE OPERATION

A, Those employing general anesthesia. B, Those employing combined anesthesia. C, Those employing local anesthesia

	Morphine and Atropine 1/8 to 1/4 Grain				Morphine and Hyoscine	Pantopon	Sodium Amytal		Nembutal	Chloretone
	1/2 Hr.	3/4 Hr.	1 Hr.	Time Not Given		1/2 Hr.	2 Hr.	1 1/2 Hr.		
A	6	1	5	4	Employed by 3	2 Pantopon with hyoscine employed by 2	2	1	Employed by 1: 2 hr.	Employed by 1: 4 hr., per rectum
B	5	4	2	1		1	2 1 employed drug 5 hr., 2 hr., and just before operation. If not sufficient, 1/6 gr. morphine is added.		Employed by 1: 1/2 hr.	Veronal, gr. 10, 1 A.M. and 6 A.M. Luminal, 1 to 3 hr. preceding operation, amt. not stated
C	1	2	1	1	.....	Gr. 1/3, 1 hr. employed by 1, Hyoscine gr. 1/150, 1/2 hr., and Pantopon 1 or 2 doses of 1/3 gr. during operation	Amytal employed by 1: 4 1/2 to 6 gr. 1 1/2 hr. before; morphine 1/8 to 1/6 gr. 3/4 hr. Employed by 1: 7 1/2 gr., 1 1/2 hr.; morphine Employed by 1: amytal in A.M.; morphine		Employed by 1: 4 1/2 gr., guessing at amt. sufficient to have patient sleeping but able to talk. No morphine.	Avertin employed by 1: amt. sufficient to give about 60 to 80 per cent surg. anesth.

It is worthy of note that the preliminary sedatives used by those who rely on general gas anesthesia are limited practically to small doses of morphine, or an opium derivative, with very little recourse to barbiturate or other basic anesthesias. (Basic anesthesia, as here used, is meant to imply a preliminary sedative medication of sufficient dosage to keep the patient in a condition which approaches surgical anesthesia.)

When a patient is under too deep a basic anesthesia, it is difficult for the thus only a very few minutes of inhalation anesthesia is experienced by the patient. It is also apparent that a large majority of the surgeons wish to make sure of voice and hemostasis at the end of the operation, before the neck is closed. This, it appears, can be accomplished with a general inhalation anesthetic as well as with one of the other types of anesthesia.

The important element of freedom from psychic shock is well taken care of when general anesthesia is employed.

Several men mention the possibility of forcing oxygen into the lungs if a tracheal collapse should occur, yet there is a diversity of opinion as to the feasibility of this procedure. It can, however, be accomplished if an intratracheal method is employed. It seems, however, that the greatest reliance will be placed on a tracheotomy and the employment of a tube of a flexible nature, and of sufficient length to reach farther into the trachea than the ordinary tube does (Koenig tracheotomy tube).

Ether, so far as can be judged by the answers to the questionnaire, is a thing of the past in thyroid surgery.

COMBINATION ANESTHESIA

The main idea in the use of combined anesthesia, in which the neck is infiltrated with novocaine and a very light gas anesthesia superimposed, is that there is a block of painful stimuli to the higher centers, as pointed out by Crile when he described his "anoci-association" anesthesia. It seems, however, that the tendency is more and more toward a basic anesthesia accomplished by the use of one of the newer barbiturate groups, or avertin, plus anoci-association.

A much higher percentage of those using combined anesthesia resort to a basic preliminary, than do those favoring a general anesthetic. Many who have in the past employed the combined type have changed to general. (This is mentioned merely to show the trend, and may perhaps be explained by the fact that more expert anesthetists are available than has been true in the past.)

LOCAL ANESTHESIA, ETC.

Local anesthesia, cervical block, and surgical anesthesia obtained by means of avertin or a barbiturate, are used by a comparatively small group. Those preferring local anesthesia and using it almost exclusively, give as their reasons, in the main, absence of respiratory difficulties and freedom from heart damage. A few of the users of gas anesthesia feel that the latter point is overemphasized in "goiter heart." Local anesthesia is felt to be of definite value in some types of intrathoracic goiter.

In some instances where a local anesthetic alone is employed, it is because of the fact that expert anesthetists are not available.

A contraindication to local anesthesia, as voiced by many men, is the accompanying psychic shock. A certain element of this psychic shock is often noticed in combined anesthesia also.

A few of those favoring local anesthesia feel that they have better control over the patient with that method. When a basic anesthesia is used in a sufficient dose to produce surgical anesthesia, or closely approaching it, it is practically impossible to rouse the patient sufficiently on the table to assure intact voice and complete hemostasis. Furthermore, basic anesthesia keeps the patient in a tranquil state, sometimes for hours after the operation. That hypoventilation is present when this tranquil state exists is mentioned by several of the collaborators and in the literature, and the point is made that atelectasis and other pulmonary complications may follow. These complications, however, can in a large measure be avoided, if hyperventilation is instituted every few hours during the day of the operation, by means of CO_2 and oxygen inhalations, until the patient is able to breathe deeply of his own accord. This is a simple procedure requiring only a small tank of 5 per cent CO_2 and oxygen, and an ordinary, closed face mask. This method was brought to our attention by one of our anesthetists, Dr. J. J. Buettner, and is not employed nearly as much as it should be. We might add that another factor to be considered, when basic anesthesia is used, which keeps the patient in a semiconscious state for several hours, is the economic one regarding constant nursing attendance. These patients cannot be left alone.

The importance of a good night's rest preceding operation is stressed. (This

cannot be obtained if rest is broken by repeated administration of sedatives during the night. It is possible to give a sufficient dose at bedtime.)

CONCLUSIONS

It seems then, from all that has been said, that a properly administered gas anesthesia is safe, but that it may at times be highly essential that a local anesthesia be employed. For this reason, if for no other, every surgeon doing thyroidectomies should perfect himself in the administration of local anesthesia.

Combination anesthesia is a safe method, when the surgeon is trained in its use, but there is a certain element of psychic shock present when it is employed, unless a fairly large amount of gas is used. Local anesthesia is undoubtedly effective in the hands of those who have perfected themselves in its use, but it has more limitations than either of the other two methods, providing the patient is considered from the psychic standpoint.

It is apparent that most surgeons do their best work, when the patient is directly under the control of an expert anesthetist giving a general gas anesthesia, but many have confidence in other methods and would probably work at a disadvantage, would be mentally disturbed, if they were obliged to operate with their patients asleep.

Thyroid surgery differs from other types of surgery in many respects. It demands, primarily, a comprehensive understanding of diseases of the thyroid gland and their complications. The problems of anesthesia, as related to this type of surgery, are also quite different from those of operations elsewhere in the body. The inestimable value of applied psychology, practiced by both the surgeon and the anesthetist, in the preoperative period must be stressed. It is during this period that a fair decision may be made as to the type of anesthesia which is best suited to the individual under consideration. Thyroid surgeons should develop a certain amount of "anesthetic versatility." It will be reflected in safety for their patients and comfort for themselves.

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EXPERIMENTAL ECK FISTULAE

WITH INSTRUMENT

LEWIS W. ANGLE, M.D.

KANSAS CITY, KANSAS

WHILE performing Eck's fistulae on dogs for experimental purposes, we were confronted with the task of selecting the best method of obtaining an anastomosis between the inferior vena cava and the portal vein. After many trials with varying success by use of clamps devised by Horsley,[1] the hemostatic suture of Bird[2] and the cutting suture of Fishback,[3] we concluded that a small instrument would act most effectively and at the same time be a labor-saving device.

The lateral anastomosis of the inferior vena cava and the portal vein was described about fifty years ago by Eck.[4] During the last century little was done to improve the technique employed by Eck, but in the last score of years, many methods and several instruments have been devised and described.

The original method, as employed by Eck, was to place two rows of sutures, the first being completed and tied; the second or anterior row remained untied until after an opening had been made between the two walls of the vein, this necessitating a very rapid and accurate manipulation of the cutting material and tying the anterior row of sutures. This same procedure was employed by Stolnikow[5] with the exception that he used a guide wire and needle on the end of scissors.

Pawlow and Necki[6] and earlier workers employed the same method, some using silver wire tips and others using copper, but these methods are now obselete since the instruments often fail at a crucial moment.

In 1904, Sweet[7] employed a wire cautery. The posterior row of sutures were placed and a cautery wire was then placed on a silk suture. The anterior row of sutures being placed, the cautery was then turned

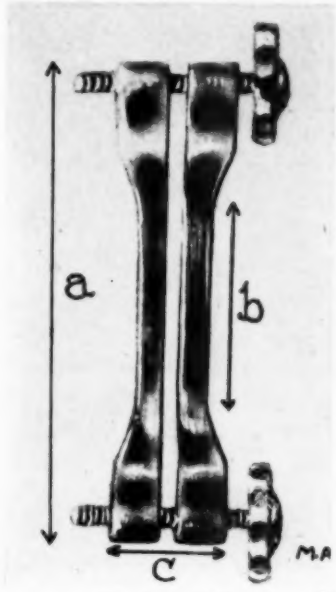

FIG. 1. $a = 2$ in.; $b = \frac{7}{8}$ in.; $c = \frac{1}{2}$ in.

on, which burned out a lumen between the two vessels. This would be an excellent method, were we always certain of the extent of the action of the cautery.

Tansini and Perrincito[8] attempted an end-to-side anastomosis which is obviously very satisfactory but causes entirely too much distortion and traction on the vessels which can be moved only a short distance from their beds.

Queriolo[9] used a rigid tube to facilitate an anastomosis, but this method proved very unsatisfactory for the same reason as that of Tansini[10] because of too much traction on the immediate and adjacent vessels and structures.

Berheim and Voegtlin[11] described a method by which the portal vein and vena cava are first sewed together with

a curved needle and silk using a continuous suture. Another row of sutures are placed parallel to this, then a specially

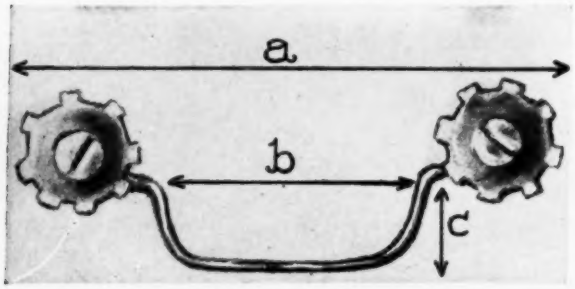

Fig. 2. $a = 2\frac{7}{8}$ in.; $b = 1\frac{7}{8}$ in.; $c = \frac{5}{8}$ in.

constructed pair of scissors with sharp points are partly opened, one blade entering the lumen of the portal vein, and the partition between the two is then cut. A previously inserted suture at the point of the puncture of the scissors is quickly tied.

Fischler and Schroder[12] were first to employ the use of a cutting suture by applying a posterior row of interrupted sutures, then placing a cutting suture of heavy black silk through the two veins, then laying the anterior row of sutures; this was followed by sawing out a window by alternating traction from side to side on the cutting suture. This method was later modified by Mann[13] and also Fishback who used a continuous suture instead of an interrupted suture.

Special instruments have been devised, some of which have worth, while others seem of little practical value. Jeger[14] devised an instrument somewhat similar to a gastroenterostomy clamp with the third or middle blade. Horsley[15] described a somewhat similar instrument with only two blades which seems by far the more suitable instrument, the chief drawback being the size of the instrument and the necessity of using two clamps instead of one. Stewart also described an instrument which consists of large oval blades. Joani's[16] clamp is of somewhat the same structure as that of Horsley, following the design of a gastroenterostomy clamp. One of the most recent methods described is that of Bird[2] in which he employs a hemostatic stitch, resulting in everted pleats in both vessels. The margins of

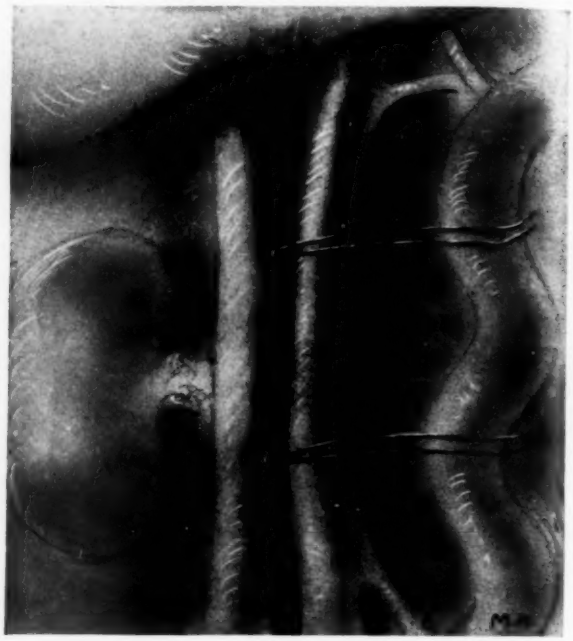

Fig. 3.

these pleats are opened and later form the window of the anastomosis. The posterior row of sutures is then placed; following this the anterior row of sutures is placed; then the hemostatic stitch is withdrawn, thereby leaving an anastomosing window. This method is similar to the procedure when an gastroenterostomy clamp is used, the hemostatic stitch taking the place of the clamp.

The method of anastomosis employed by Eck is open to criticism from several points, the chief of which is that one does not have complete control of the flow of blood when the window is made. The employment of scissors is equally as hazardous since the chances of cutting out the suture line or of tearing the wall of the vein are too great, and the length of the window is dependent upon the length of the scissors' blade. The same uncertainties apply to the use of the cautery wire. The use of the rigid tube and the end-to-side anastomosis creates too much distortion and traction of the

vessels involved and the surrounding structures.

The clamps employed by Horsley, Joani and Jeger are good in general design but they are rather large and bulky for work in a limited space. The method employed by Sweet is extremely slow as is any method in which one employs an interrupted suture. The method described by Fishback seems excellent, rapidity being gained by the use of an uninterrupted suture, but the cutting suture does not seem to be as reliable as a clamp, for the chance of tearing through the anterior or posterior row of sutures is quite great, which would result in an extremely bloody operative field or disaster. Bird's operation necessitates a third suture line (the hemostatic suture which is pulled), thus requiring much time.

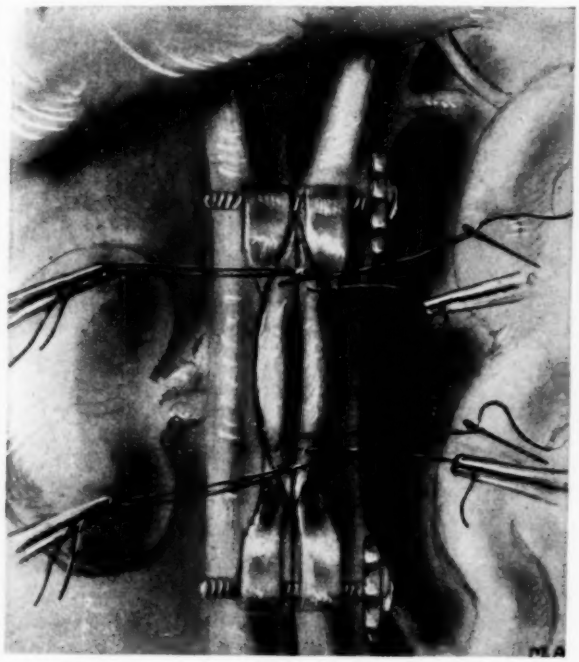

Fig. 4.

EXPERIMENT

Animals: Dogs were used in all experiments, a large female weighing at least 15 kg. being most desirable.

Instruments: Ordinary laporatomy instruments were used, in addition to a small straight forceps without teeth which was used as a needle holder, four No. 4 phoenix needles 1.5 cm. in length, threaded on No. 0 black silk which has been boiled in oil, and the instrument shown in Figures 1 and 2.

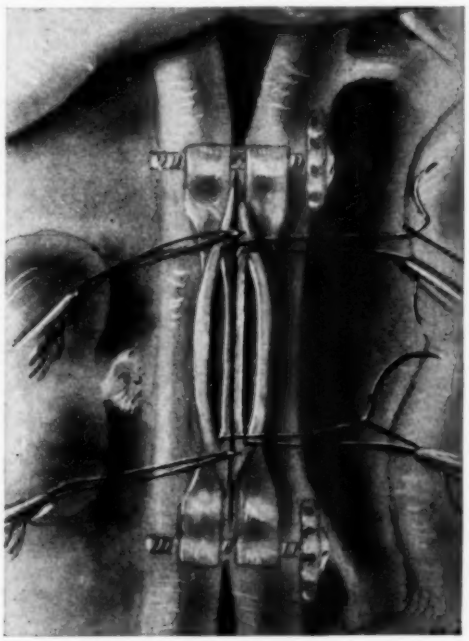

Fig. 5.

Operation: Ordinary preparations were made as for other abdominal operations, and under ether anesthesia an s-shaped incision was made as described by Mann.[13] The intestines, stomach, and duodenum were well packed off, exposing the inferior vena cava and portal vein; the portal vein being partially obstructed from view, the fat and fascia were dissected away, care being taken not to tear small adjacent vessels or the wall of the portal vein. The surface of the vena cava not being covered it is easily accessible. Therefore we have two vessels easily movable from their beds lying parallel to each other as shown in Figure 3.

The retraction being carefully done by an assistant we begin from the portal side by taking a small bite in the portal vein, then the vena cava. This suture is tied twice and the ends are cut, about 5 inches being left to which a clamp is attached, this suture being used as a guy suture. About 4 cm. distal to this a

like suture is placed, which is the caudal guy suture and cut in like manner, thereby leaving two surfaces of the vein in close apposition. (Fig. 3.)

The clamps are now removed from the two guy sutures, and the sutures threaded between the two blades of the instrument, after which the clamps are again placed on the guy sutures. The instrument is now held in a position so that its long axis is parallel to the long axis of the vessels, then placed so that the approximating vessels will lie between the two blades of the clamp (Fig. 4). Thus the clamp is placed so that the entire lumen of the vessels is not occluded, thereby leaving a continuous flow of blood in each vessel and at the same time leaving a sufficient amount of blood vessel wall above the blade of the instrument for an anastomosis. The screws are now tightened to a point which will approximate the intima without destroying the endothelial lining. The pleat of the portal vein is grasped with a small mouth-toothed forceps and a long pointed scalpel blade, and a longitudinal opening is made about 3 cm. in length. The pleat in the vena cava is done likewise, thereby leaving two windows in direct apposition which will later form the anastomosis (Fig. 5).

The cephalic suture which later forms the posterior row of sutures is now placed by taking a bite through both vessels just proximal to the opening in the vessels. This suture is tied, the clamp being placed on the short end and the long end laid aside. The posterior row is now laid, the cephalic suture being used. Beginning at the upper, we place continuous (Fig. 6) uninterrupted sutures to and around the caudal suture, care being taken that each suture is drawn tightly. This suture is now tied to the short end of the caudal suture and cut. The anterior row is now laid (Fig. 7) by using the caudal suture and placing uninterrupted sutures up to and including the short end of the cephalic suture to which it is tied, thereby forming an anastomosing window between the two veins.

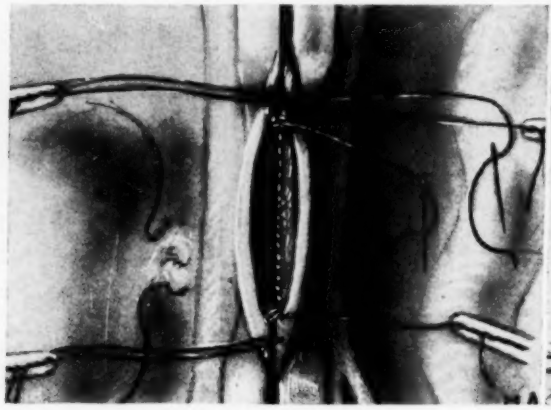

Fig. 6.

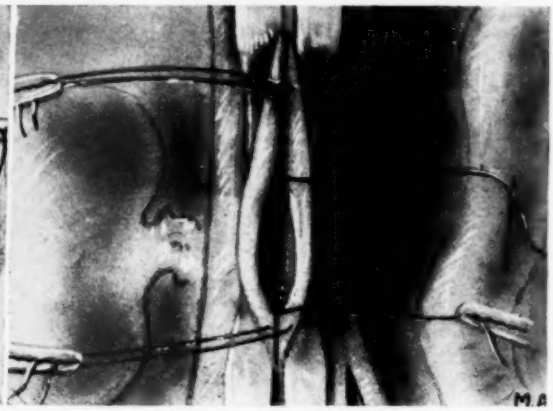

Fig. 7.

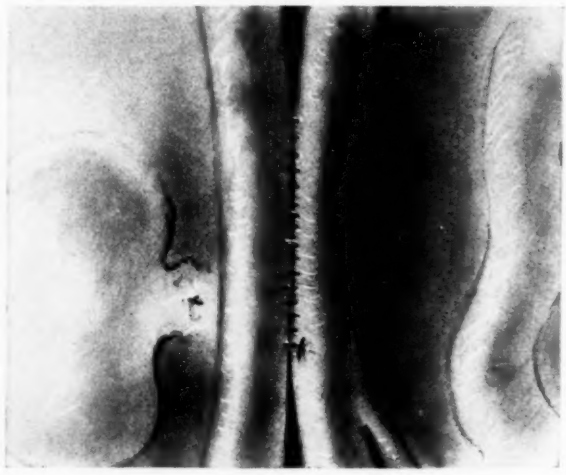

Fig. 8.

The screws are now released with caution to note any oozing. In case oozing is

present a suture can be taken at the point of bleeding. The veins are now released to their original beds and the guy sutures cut (Fig. 8).

COMMENT

The method described here is obviously easy in procedure, requiring the small instrument which is large enough to function properly and at the same time small enough to be out of the operator's way when suturing in a small field. Its advantages are:

It controls bleeding at all times.

We maintain a continuous flow of blood through vessels at all times.

One can easily regulate the amount of pressure to such a small degree as will not cause injury to the intima.

This method does not require a third stitch.

The instrument can easily be placed and adjusted.

Unlike all other instruments devised we are not handicapped by the presence of a handle.

This work was done at the experimental laboratory of Bell Memorial Hospital, University of Kansas Medical School.

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EDITORIAL

THE RESPONSE OF THE PHYSICIAN TO THE PROBLEM OF ASPHYXIA

THE response of the Profession to the problem of asphyxia must be prompt and energetic. While sporadic attempts to treat asphyxia, medically, not infrequently occur, the problem has not been attacked with any degree of seriousness. In view of the vital statistics relative to this problem published by THE AMERICAN JOURNAL OF SURGERY, in December, 1932, it is imperative that an organized and well-directed activity should begin without delay.

This organized activity should have the three-fold objective of encouraging research, supplying instruction, and providing the necessary treatment. There are two large groups now engaged in treating the problem of asphyxia: the medical group, and the non-medical group.

The first group includes the entire medical personnel; namely, physicians, dentists, and trained nurses who act as operating-room technicians. Contact is to be made with these groups through the medical societies, national, state, county, and local; the various boards of licensure, the American College of Surgeons, the American College of Physicians, the Ameri-

can Hospital Association, the Medical Departments of the Army and the Navy; Municipal and National Health Bureaus; Medical Schools, graduate and post-graduate; and, finally, the Medical Departments of lay organizations, for example, the Police, Fire, Gas, Bureau of Mines; the Red Cross, and the Medical Departments of the Insurance Companies.

Dentists should be approached along the same lines. Nurses may be approached through the local and the national organizations; through nursing periodicals, and through organizations having to do with qualifications for technical experience.

The non-medical group which includes the Fire Department, the Police Department, Gas and Electric Companies, the Bureau of Mines, Federal Life Saving Corps, as well as lay persons instructed by the Red Cross and other agencies, are all recognized as extremely important in meeting this type of fatal accident.

Contact is to be made with the non-medical group with a view of assembling the information which they, collectively, possess, and pointing out, in a spirit of cooperation, the limitations of the treatment which they are capable of extending.

The medical relief of asphyxia is, at the present time, entirely disorganized, and inefficient to a degree which has brought about the absurd situation not uncommonly seen, in which the physician or the hospital calls upon a lay group represented by the Police or the Fire Departments to assist in the resuscitation of his patients.

The necessity of organizing medical opinion in this regard becomes evident when it is seen that no classification of the stages of asphyxia has been, generally, introduced; and that every method proposed for the relief of this condition is enthusiastically proclaimed by its inventor, as the *ideal* for every case regardless of the degree of asphyxia present.

Representatives from both the medical and the nonmedical group would provide reliable first-hand information covering the limitation and the functioning of their respective groups. They would help to prepare and disseminate propaganda material directed to their respective groups. They would, also, be of invaluable help in the integration of available information.

The custom of providing various forms of awards such as medals, newspaper publicity etc. to members of lay teams who save life threatened by asphyxia should be so modified that the life-saver might include, in his treatment, immediate recourse for medical aid, instead of postponing this call until he has exhausted every hope of accomplishing the resuscitation by himself. To bring immediate qualified medical help to the afflicted patient should, in every way, be encouraged; and a spirit and a desire for co-operation should replace the homicidal competition so frequently practiced. To bring a properly qualified physician to the side of a profoundly asphyxiated patient is infinitely more important than continuing a hopeless, prone pressure Schäfer treatment for an indefinite period.

It is readily recognized, however, that until the physician proves his ability to carry on a more scientific procedure than that practiced by the lay group, he is not at all likely to be asked to cooperate.

The argument has been advanced that asphyxia is the result of the many specific causes of asphyxia; and, cannot, therefore, be considered a cause of death. Is not acute asphyxia, however, the common terminal, fatal complication; and, therefore, the immediate cause of death? Since proper relief usually saves the patient's life, is it not more correct to consider the specific causes of asphyxia as the predisposing causes of death, the immediate cause being the asphyxial state? Among the various causes of asphyxia are the following:

Anesthetic overdosage, local or general
Foreign body obstruction due to aspiration in a conscious or unconscious subject
Carbon monoxide poisoning, as illuminating gas or automobile exhaust
Submersion
Asphyxia neonatorum

Electric stroke
Smoke poisoning
Extratracheal pressure, from tumors in the neck or mediastinum, mechanical, or other causes
Intratracheal pressure from tumors in the airway, such as malignant growths, diphtheretic membrane, etc.
Drug poisoning from morphine, hyocine, avertin, sodium amytal, etc.
Acute alcoholism
Anaphylaxis
Poliomyelitis.

A survey should be conducted both in this country and abroad for the purpose of integrating information concerning asphyxia with special reference to the methods now available for its treatment from a theoretical, as well as from a practical aspect. Research directed to the investigation of the respiratory and cardiac complications, resulting from the various specific causes of asphyxia, should receive adequate endorsement.

Intensive instruction should be directed to the common recognition of the stages of asphyxia; and the correct treatment of each stage should be clearly pointed out. Scholarships and prizes should be made available for studies in gas therapy.

Instruction should be concentrated upon the popularization of laryngoscopy, in the unconscious patient, in contradistinction to the technique commonly practiced, in the conscious patient, in the routine procedure of bronchoscopy. Laryngoscopy of the completely anesthetized or asphyxiated patient is a procedure that is so simple than anyone may acquire the technique. Laryngoscopy as practiced for bronchoscopy is technically difficult. These differences are not generally understood. Laryngoscopy is the point upon which the scientific medical treatment of acute asphyxia turns. This technique should be well understood, and as informally available, as is the inspection of the eye, the ear, the nose and the throat. Suitable instruction and practice places the procedure, entirely, within the reach of any medical man; or nurse technician.

Finally, a Medical Resuscitation Service consisting of an ambulance specially equipped and continuously covered by a team of qualified physicians under salary and sponsored by a centrally located general hospital, should immediately be available. This Service would serve the double purpose of treatment and demonstration, with a view of ultimately inducing the municipal authorities to take over such facilities. This service would be available as a medical rescue service for the private physician, and would be a source of controlled statistics.

Paluel J. Flagg

AMERICAN ASSOCIATION FOR THE STUDY OF GOITER AWARDS

THE American Association for the Study of Goiter, for the fourth time, offers Three Hundred Dollars ($300.00) as a first award, and two honorable mentions for the best three essays based upon original research work on any phase of goiter presented at their annual meeting in Memphis, Tenn., May 15th, 16th, and 17th, 1933. It is hoped this will stimulate valuable research work, especially in regard to the basic cause of goiter.

Competing manuscripts must be in English and submitted to the Corresponding Secretary, J. R. Yung, M.D., 670 Cherry St., Terre Haute, Indiana, U. S. A., not later than April 1, 1933. Manuscripts arriving after this date will be held for the next year or returned at the author's request.

The First Award of the Hamilton, Ontario, Canada, 1932 meeting was given Donald McEachern, M.D., Johns Hopkins Hospital, Baltimore, Md., "A Consideration of the Mechanism of Hyperthyroidism based upon its Effect upon Cardiac and Skeletal Muscle."

AMERICAN PHYSICIANS

GEORGE MCCLELLAN

GEORGE MCCLELLAN was a character, an eminent surgeon, and the founder of Jefferson Medical College of Philadelphia.

He was born at Woodstock, Connecticut, December 23, 1796. His father was the principal of the Woodstock Academy where George received his early education. He went to Yale and received his B.A. in 1816. After leaving Yale he entered the office of Dr. Thomas Hubbard, later professor of surgery in the Medical College of New Haven, but after a year he moved to Philadelphia, where he became a pupil of John Syng Dorsey. He entered the medical department of the University of Pennsylvania and received his M.D. in 1819, his thesis being, "Surgical Anatomy of Arteries." While a student he was resident undergraduate in the Philadelphia Almshouse, where he dissected and did on the cadavers all the then known surgical operations.

McClellan began practice in Philadelphia and became known as "a bold, talented surgeon." He opened a dissecting room and gave private courses of lectures. In 1821 he founded an Institution for the Diseases of the Eye and Ear, which lived for four years.

After great opposition and a spectacular 60 mile ride to the capital, Harrisburg, on horseback, where he got a charter from the legislature, McClellan with a few coadjutors founded Jefferson Medical College (1825). There he was professor of surgery from 1826 to 1838 when the trustees vacated all the professorships and excluded McClellan, for reasons unknown.

He at once started a third medical school. He got a charter for "The Medical Department of Pennsylvania College" (1839), the school starting with 100 pupils. It endured until the time of the Civil War.

He was one of the pioneers in the extirpation of the parotid gland. In 1830 he extirpated the scapula and the clavicle for malignancy, without anesthetic and without artery forceps. Present-day surgeons might contemplate such an operation. McClellan, also, resected the ribs, then a novel operation.

S. D. Gross became his private pupil.

In 1820 he married Elizabeth Brinton. They had five children; one of the grandsons was George McClellan.

He had a passion for the good things of life, fine horses and racing. He died poor . . . "He bought town lots, built houses and lost money."

He was stricken with "an ulcerative perforation of the small intestine" and died suddenly, May 8, 1847.

T. S. W.

[From Fernelius' Universa Medicina, Geneva, 1679.]

BOOKSHELF BROWSING

ULRICH VON HUTTEN

PART II*

BEN WOLEPOR, M.D.

MONTREAL, CANADA

III. HUTTEN

PRACTICALLY all that one reads of Hutten nowadays is that famous satire verging on the burlesque, the "Epistolae Obscurorum Virorum," and even that is rarely read. The writings of Hutten, however, fully repay the careful reader; for they offer much insight into the religious and political situation of the day and besides, reveal that which is probably more interesting than man's activities, the stirring view of an interesting character. Hutten's work is the "L'os medullaire" of Rabelais. It requires only "par curieuse leçon et méditation frequente, rompre l'os et sugcer la substantifique moelle." In the laborious decade, 1513 to 1522, his thoughts and writing, his actions are enclosed which began with the "Praise of Folly," and finished with, "The Anabaptism." Hutten was a turbulent, over-confident person. He was familiar with all the important individuals of the day and made friends and enemies amongst the most exalted in the land. He was familiar with Maxmillian the Emperor, the Archbishop, Elector of Mayence, Albert; Erasmus and Reuchlin, Luther and Zwingli the reformers, Hogstraten the Dominican, Sikkingen the cavalier and Karsthans, the peasant. A humanist, political writer, a theologian for the time-being and warrior, he had assayed many fields of endeavor and sustained many battles of pen and sword. Capricious, independent, versatile but lacking in profundity, a man of generous impulses, fiery and unrestrained. He eagerly entered the fray, irrespective of outcome, for a disputation was as the breath of life to him and he warmly embraced various causes, bounding from one to another without fully utilizing the resources of any. Misfortune could not daunt him nor fear of death subdue his fearless spirit. He resembled the king of birds in rapacity, courage and boundless energy. He could laugh as heartily at the pricks of ill-luck as at the folly of his enemies. His brain was continually active and from it poured forth appeal after appeal, summoning men to patriotism, of which he was a self-appointed apostle. Hutten joined the ranks of Reuchlin and Erasmus, the scholars, who by a new privilege were permitted to perform their life-work outside the Church, and eagerly availed himself of the treasures of antiquity, recently unearthed. When religious authority, frightened by the imposing

*PART I appeared in the January issue of the JOURNAL, page 152.

array of the secular literature (a product of paganism), wished to crush it, Hutten joined forces with Reuchlin to protect what both considered destruction of the new truth. Education was proceeding apace. Langius, was director of a new school at Munster in 1483, Hegius at Deventer in 1475, Dringeberg, founder of a famous school at Schelestadt in 1480. Agricola of Groningue spread the new teaching which opposed scholasticism. The members of the old universities were frightened. Their leader, John Hogstraten, and the Mendicant brothers of Cologne, guardians of the traditions of old, condemned in the name of religion and the sacred rights of theology, the studies and introductions of the pagan poets which had inspired the new universities and the wandering hordes of eager students. It was not long before the school, where Dringeberg taught, had nine hundred students. On the model of this school Nuremberg, Ulm, Augsberg, Frankfort and many others, erected schools where the study of the ancients flourished at the expense of scholasticism.

A war was on! Not about foreign markets, fishing rights or territory, but a battle over ideas, an encounter which was eventually to reduce Germany in the Thirty Years War from a nation of eighteen million to four. An army of learned men, headed by Reuchlin and Erasmus, passed from the defensive to the offensive and forced several universities to adopt the newer methods. Powerful, enlightened princes such as Frederick III and Maxmillan I the Electors of Saxe and Brandenburg, the Dukes of Bavaria and Wurtenburg aided them. A vigorous onslaught took place between the humanists who wished to unite the study of the humanities to theology, and the scholasts who desired to enclose the human spirit in the persistently narrowing circle of their own restricted thoughts.

Said Hutten in one of his elegies:

I hastened whilst my joyous and robust youth flourished under the influence of my studies, as the year under the breath of spring, to wander over the world and visit far countries; to live everywhere, seeing the most suitable things. The wide world was my native land, my home, my fields. Whereas others hesitated to leave the family joys, to drift away from the land of their fathers, I wished to learn, understand, become a person of consequence through my own efforts and save my name from forgetfulness. The same desire has in former times impelled the Sage of Samos who visited the Italian shores and the divine Plato also traversed many lands.

Eleg. X

Plus placuit loca posse mihi peregrina subire,
Dum vigeat studiis laeta juventa suis,
Dum vigeant ami, vegetique simillima veris
Exhibeant vires tempora prima bonas.
Nusquam habitare magis, quam me delectat, ubique,
Undique sunt patriae, rura, domusque meae.
Cumque alius dulces dubit que liquesse parentes.

At Erfurth, Hutten became the disciple of Crotus Rubianus, one of the most vigorous assailants of monastic studies. Driven out of Erfurth by a dread pestilence, (syphilis?) he went with Crotus to Cologne. Arnold de Tongres and Ortuinus Gratius, professors at the university at Cologne, would have none of the newer learning. In Frankfort, where the Elector of Brandenburg had erected a new university, Hutten, now eighteen years of age, assisted at the consecration. He was given a Master of Arts and lived there for two years, studying and writing verse. In 1508 he again went on his travels for no known reason save that of his inherent Wanderlust but now he suffered the tribulations of the unknown and unwanted. He begged his bread from door to door and passed many cold nights before inhospitable thresholds, deaf to his entreaties.

Ore cibum petii peregrinas pauper ad aedes,
Ante fores somnum gelida sub nocte petivi,
Vix raro surdas jussus inire domos.
More viros nostro potuissem quaerere doctos,
Inpediit coeptam pestis amaram viam.

He at length arrived in the city of Greifswald, which had a university. He was well treated at first, but a quarrel between

the poet and the Professor of Law, Henning Loetz, who was conceited, and joked at von Hutten's syphilis (that had accompanied the wandering poet for two years and which had prevented him seeking, from shame, the assistance of the learned) displeased Hutten and made him leave Greifswald. Weak and ill he took to the road again, was waylaid by thieves at the walls of Rostock, beaten and robbed of his clothing, and his manuscripts stolen and, with crude humor, the brigands told him to sing elsewhere for his bread. The important men of Rostock, who admired the vagrant poet's work, helped him after this unfortunate encounter. He recovered his strength at the home of Egbert Harlem, surrounded by the latter's pupils who eagerly absorbed the secrets of the poetic art. Well again, the poet resumed his travels. He had dedicated his life to Letters; refused reconciliation with his father, who wished him to study Law; but it would be as easy to clip the wings of the eagle or hood the falcon as to chain the humanistic vagabond to a definite place, for he had fever in his blood, the never relenting desire to visit far places and regard strange objects. Hunger and cold were afflictions it is true, but then the young poet could find rhymes for these words, and Hutten worshipped the Muse more than he did his own welfare. He arrived at Vienne where he received a brilliant reception and gifts from the Archbishop Staniles of Turzo; Joachim Vadian admired his poetic skill, but he quarrelled with the rector of the university, Heckmann, a sworn enemy of the new studies who refused to let him teach Latin poetry. Threatened to be thrown into prison because of his furious retorts, he left for Italy and returned to Germany three years later. The intervening period was entirely one of vagabondage, accompanied by an intolerable wretchedness. He participated in the Reformation with zest on his return. He was very inhospitably received by his father who regarded his studies and life as a frivolous waste of time. Former acquaintances were astonished at his returning home without a lawyer's degree. Hutten was not very much concerned, however, with their undesirable attitude. What concerned him was the dispute of Reuchlin. He and Rubianus wrote the famous "Epistolae" which apparently proceeded from the principal university towns of Germany, signed by the obscure names of Bachelors of Art, Professors of Theology, student clergyman, monks. These letters were addressed with seemingly great respect and admiration to the most important theologian on the faculty of Cologne, to the very wise and excellent Ortuinus Gratius, Master of Arts, poet, orator, philosopher, theologian, and more also if he would so desire! Thus made its entry the famous letters, whose ribald, boisterous accents overwhelmed the Dominicans; their dignity could not withstand mocking laughter.

It were as though the stream of human thought, long confined by artificial banks had, with a repressed, irresistible fury, burst walls grown inadequate with the natural decay of age and overflowed its banks, seeking new beds. The various intellectual pursuits of men throve and versatility marked the actions of the brilliant. Leaders of thought became adept at theological disputation, literature, languages, and even medicine. The ferreting impulse which had long since been denied its natural outlet because of suppression, became overwhelming in its intensity and von Hutten, the politican, and littérateur, warrior, became a doctor; assailed the entrenched walls of a senile medicine with the ease that he had vaulted hoary, ecclesiastical confines and all his actions are marked by a furious onslaught that swept aside obstacles. Just as one country could not restrain his wanderlust, so was it impossible for one field of thought, ample enough for most men, to hold his intellectual curiosity and one regards, amazed, the boldness of this belligerent poet, who so truly reflected an uneasy, turbulent period of history.

To be an educated man, that is one versed in the humanities, was to possess the universal password, the "open sesame" of scholardom. Perhaps at no other period in recorded history did the world, irrespective of race, so welcome the travelling scholar. Erasmus was as much at home in England as in Germany. Italy, France, Germany, were merely places where learned men congregated and not fatherlands. One's fatherland lay in the mind, in the soul that had fostered and appreciated genius. To be learned was to be welcome. To be a poet meant that the doors of the great were accessible thresholds. Sick, feeble, rotting with a malignant disease, Hutten knew that as long as he could write elegies and retain his manuscripts, the world would be his home and humanistic universities his camping grounds.

The world, it appeared, resembled the human body, that, growing accustomed to disease, shows its dissatisfaction and muted rebellion by a sub-threshold symptomatology but when confronted suddenly with determined, virulent antagonism, rebels with a marked reaction. The initial chill and fever of pneumonia is no more dramatic than the furious rise of emotion that Europe displayed at the accession of the irresistible current of new thought that pervaded the political, literary and religious fields; that altered Europe and man's institutions and produced the Renaissance and Reformation. The period of quiescence that preceded these events was as deceptive as the incubation period of an infectious disease. Reuchlin, translator of Terence, author of a comedy against the monks for which he was never forgiven, continued his attacks against the preachers of his time; a man so infatuated with the love of learning, even that of the despised Jews, that he did an incredible thing, and made friends of rabbis with the feverish intensity to learn more of the language and customs of the race that had created a noble conception of God. He even approached the dangerous ground of the mysteries of language in his book "De Verbo Mirifico" and on the footsteps of Pic de la Mirandole, connected Plato with Pythagoras, the latter to the Jews; seeking, by words as symbols, the Eternal Being, a dangerous pastime; leaning for support on the occult science of the Jews in his book "De Arte Kabbalistica."

Erasmus published the New Testament for the first time in Greek with explanatory notes; seeking to amend errors by pointing out the original sources of Christianity; One must recruit one's strength in the primal fountain. To wander about emerging streams meant being lost in labyrinthine maze. Perilous steps were being taken and the medieval world, fascinated, held its breath for it knew that soon would emerge a dread form that would bar scholasticism from rebellious learning and progress. Death would soon claim a cherished tradition, one in which empires, emperors, kings, prelates and peasants were intermingled, Blood would flow like water but man could no more resist the progress of truth than he could stem the passage of the years. Growth and decay were as inevitable in human affairs as in the individual body.

The Church of Rome and Germany refused to yield to compelling exigencies and fought strenuously to hold the yielding ground. After Alexander VI, Leo X not only increased the spiritual privileges of the discomfited monks but sought to invest the Dominicans with the inhuman character that had stigmatized their actions during the recently passed Spanish Inquisition. Numerous works were added to the Index, forbidding the reading of the new books, or the Classics. The innovators and their audiences were punished. The leaders of the two European camps, Liberal and Conservative, Reuchlin and Hogstraten, waged war. An amusing situation arose; a converted Jew, Pfefferkorn, over-zealous in his attachment to his new faith (his enemies cried that he had deserted Judaism to escape hanging by his countrymen) claimed that the Talmud and a few other Jewish books contained propositions that imperiled the existence of Christianity; whereupon Hog-

straten had asked permission of the Emperor to burn all Jewish books that were contrary to the precepts of Christianity as he conceived them. The counsel would not give him permission until it had taken the advice of a layman well versed in these matters, as it distrusted theological intensity, believing that the mind distorted by emotion was apt to err. Reuchlin was asked to give his opinion. He was thought to be one of the most learned scholars in Europe in these matters and also a devout Christian. The latter failed to find any offensive statements in the sacred books of the Jews but suggested that the tracts relating to witchcraft be destroyed. The Dominicans, thwarted in their desire for destruction, turned to rend Reuchlin who, without knowing it, had prevented another Inquisition. It was an easy step from the destruction of the works of the mind to that of the brain itself. Hogstraten appealed to the Faculty of Theology at Cologne before Ortuinus Gratius and Arnold de Tongres, and accused Reuchlin of the very grave charge of heresy. The Emperor ordered the conflicting groups to hold their peace but he could not suppress the affair. A vital issue was at stake; an inconceivable thing had occurred. A layman had, in a religious matter, given an opinion contrary to the view of the highest faculties of the land and had defied the ruler of one of the most powerful religious orders. This was more than a matter of burning books. The question was: who shall rule, the clergyman or the layman, the Church or the State? Power was the objective, although skilfully disguised by the conflicting bodies. Was not the sphere of knowledge and belief the treasure and possession of the Church and had it not been confided to that body of men to eternally guard? Was the world to feast upon a treasure meant for the chosen few? Therein lies one of the differences between scholasticism and humanism. The latter thought a treasure useless that could not give of its substance to the desirous ones, the humanists scattered their largesse with free and ample hands. They showered their gifts on the wayside, in the fields, schools and cities. Their store was inexhaustible as was the boundless capacity of their love and interest in mankind. "Grow self-sufficient," they cried, "and you will make your State righteous and worthy."

Under the standard of Hogstraten were arranged all the professors of the Faculty of Theology, logicians, doctors, bachelors in the seven arts and the hosts of monks, Dominicans, Franciscans, Carmes and Mendicants, determined to preserve intact the authority of the Church in matters of religion, the superiority of the Faculty of Theology in the universities and the power of the clergy over the human conscience. Under Reuchlin, the partisans of the newer learning flocked, humanists, poets, lawyers, writers in the common tongues, a few religious orders as the Augustinians and Lesser Brothers, rivals of the Mendicants, who wished to defend Reuchlin in the cause of the freedom of learning with all that it implied. When Hutten returned to Germany in 1514 the Prior of the Dominicans, Hogstraten, accused Reuchlin of heresy; demanded that he appear at Mayence before an ecclesiastical commission appointed by himself and ordered that his books be burnt, despite his appeal to the Pope. He was summoned before the Bishop of Spire. Then appeared the famous "Epistolae Obscurorum Vororum" of which Hutten was the chief author and probably Rubianus a collaborator. Gratius was furious, threatened the printer and the authors of these scandalous letters, accused all the humanists of the country, Reuchlin, Erasmus and at last ferreted out Crotus Rubianus and the chief culprit, Hutten. The guilty men rejoiced in his anger and wrote more letters. The "Epistolae" made popular the issues of the quarrel which might otherwise have remained hidden in old universities and new schools. Men who formerly regarded tradition with awe saw that it could provoke mirth and the sacred became profane. Hutten had prepared the way for Luther.

(To Be Continued)

BOOK REVIEWS

THE ADVANCE OF MEDICINE. By The Right Honorable Lord Moynihan, K.C.M.G., C.B., The Romanes Lecture, Delivered in the Sheldonian Theatre, June, 1932. Oxford, Clarendon Press, 1932.

This little gem is from the pen of one who is not only the outstanding surgeon but also one of the most charming writers of the day. It is, like everything that Lord Moynihan writes, full of meaty discussion and pithy phraseology. It is a book that we would like to see in the hands of every surgeon and an ideal present to give to the senior medical student who will get a better picture of present-day medicine and surgery and a better philosophy of the practice of medicine from these 64 pages than from any writings known to the reviewer.

The temptation to quote the *bons mots* from every page is hard to resist but lack of space prohibits our doing so. What a wonderful thing surgery would be if every surgeon took to heart the following phase: "Surgery is more than science, more than art, it is a sacrament." The author's great store of reading and scientific knowledge together with his sound judgment and clearness of vision are lucidly demonstrated in this little book which should be in the bedside library of every physician and surgeon.

A SYNOPSIS OF SURGICAL ANATOMY. By Alexander Lee McGregor, M.CH. (Edin)., F.R.C.S. (Eng.) With a Foreword by Sir Harold J. Stiles, K.B.E., F.R.C.S. (Edin.) N. Y., Wm. Wood and Co., 1932.

The latest addition to this series of handy volumes covers the subject of anatomy in the same practical manner that surgery was covered some years ago by Groves. This work will be found of interest and value to medical students and practicing physicians and surgeons will also find it worthwhile for a quick brush-up.

The book is complete and up-to-date and covers just the material that is difficult to get from the larger works.

DIE RÖNTGEN-LITERATUR. By Dr. Herman Gocht. Stuttgart, Ferdinand Enke, 1932.

The twelfth volume of "Die Röntgen-Literatur" is, like the previous ones, complete and up-to-date and makes a valuable and handy addition to the library of every roentgenologist. American as well as European literature is well represented and the author has done his job well. For bibliographic references this work may be accepted as the standard.

THE DIAGNOSIS AND TREATMENT OF POSTURAL DEFECTS. By Winthrop Morgan Phelps, M.D., F.A.C.S., and Robert J. H. Kiphuth. Springfield, Ill., Charles C. Thomas, 1932.

The first six chapters of this book are devoted to body mechanics and postural defects with the reasons therefor. Chapter VII is devoted to corrective exercises while Chapter VIII covers statistics based on the authors' experience. There is a good bibliography.

This work may be considered a distinct contribution to a subject that is of growing importance not only to all physicians but to educators as well. Common sense seems to be the keynote of this book which may be heartily recommended to those interested in the subject.

PRACTICAL OBSTETRICS FOR STUDENTS AND PRACTITIONERS. By P. Brooke Bland, M.D. Assisted by Thaddeus L. Montgomery, M.D. Phila., F. A. Davis Co., 1932.

This is an excellent work boiled down to 730 pages with 516 illustrations, including 21 well-executed colored plates.

The subject of obstetrics is thoroughly covered. Theory and speculation have no part in the text. The author clings closely to accepted facts, and presents them in a most readable manner. We glanced through the book and found that we were reading page after page, which is a test of good writing.

Students will find this work an advantage because the author has simplified many obscure and complex problems. The practitioner who wishes to review facts he once knew but which have become mentally hazy to him will welcome a work done in its concise, simple style.

All in all, anyone desiring a worth while Practical Obstetrics will not be disappointed if Dr. Bland's work comes into his possession.

RHEUMATOID ARTHRITIS AND ITS TREATMENT. By Vincent Coates and Leo Delicati. Lond., H. K. Lewis & Co., 1931.

This is a rather sketchy monograph which will enable the general practitioner to glean some information in regard to the physical aspects and treatment of arthritis. It is not, however, of particular interest to those who are specializing in the treatment of this most difficult disease as practically nothing new is brought out, and the literature on the subject is very scantily surveyed.

The two most important chapters in the book are the "Systemic Treatment" in which a very rational resume of constructive measures is outlined; and "Joint Treatment" which handles the subject of prevention of deformities in a simple and yet efficient manner.

The authors state that there is no excuse for the constantly reiterated statement that very little, if anything at all, can be done for rheumatoid arthritis. Every serious worker in this field will agree that the fallacious concept of rheumatoid arthritis as a hopeless and helpless disease should be broken down, and the main value of such books as that of Coates and Delicati lies in the fact that the general practitioner is enabled by reading them to feel that he can be of some service in at least rendering an arthritic's existence more comfortable.

OXFORD MEDICAL ADVISER FOR THE HOME. By J. D. Comrie, M.D., B.SC., F.R.C.P. N. Y., Oxford Univ. Press, 1931.

The home medical adviser is not as popular now as it was in past generations. If a book of this kind is to be put in the hands of laymen, we feel that this one is the best that we have seen for the purpose. The information given is of a preventitive nature, common-sense material, and harmless.

Alphabetically arranged in two-column dictionary fashion, the book will undoubtedly make a place for itself in many homes, sometimes to the distress of the physician, for he will have it quoted against him, but mostly we feel it will be found helpful as the usual inducements to self-medication offered in books of this kind have been studiously avoided in this volume. Like all Oxford books, it is well edited and well printed.

HANDBUCH DER GESAMTEN UNFALLHEILKUNDE. By Fritz Konig and Georg Magnus. Lief. 2 (Bogen 9–15 and Bogen 16–24). Stuttgart, Ferdinand Enke, 1932.

The two additional parts of "Handbuch der gesamten Unfallheilkunde" complete the work of scoliosis and take up the matter of injuries to the ear, tropical diseases and prevention of accidents. These parts live up to the previous ones and we are looking forward to the completion of this work with extreme interest.

NEUE DEUTSCHE CHIRURGIE: ARTHRITIS DEFORMANS UND CHRONISCHE GELENKKRANKHEITEN. By Prof. Dr. Hans Burckhardt Stuttgart, Ferdinand Enke, 1932.

Professor Burckhardt definitely outlines the anatomy, physiology and function of normal joints and shows their powers of regeneration before leading up to the characteristic changes that make arthritis deformans a clinical entity.

The most exhaustive consideration is given polyarthritis rheumatica and arthritis deformans, the two conditions being treated in detail and adequately outlined as to roentgenological findings, pathology, histology, etiology and experimental findings.

The various other arthropathies are adequately outlined with particular stress being laid on osteochondritis traumatica, osteochondritis deformans juvenilis and joint neuropathies. The association of joint disturbances with such diseases as gonorrhea, tuberculosis and syphilis is briefly but adequately described.

Practically all manifestations of joint abnormalities are considered under separate headings and the association of such diseases as scleroderma and psoriasis briefly delineated.

If any unfavorable criticisms can be made of this important and scholarly work they would seem to be based rather on the sins of omission than commission. For example, the illustrations while adequate and well-chosen as far as they go, seem to be too few in number, and the outlined treatment indicated is in most cases rather cursory and suggestive than detailed.

Perhaps the outstanding feature of the book is the exhaustive analysis of current literature and the amazingly complete bibliography.

ACUTE INTESTINAL OBSTRUCTION

MONROE A. McIVER, M.D.

SECOND INSTALLMENT

PART I: THE DISEASE

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Chapter IV

VARIETIES OF OBSTRUCTION (Continued)

Bands and Adhesions (Continued)

Early Postoperative Obstructions. Obstructions caused by bands and adhesions arising early after operation form an important and interesting group. The obstruction is usually due to recent inflammatory adhesions and is often complicated by local paralysis of the bowel from peritonitis; indeed, certain of these cases really form a borderline group between mechanical and functional obstructions, the functional element being superimposed upon a partial mechanical obstruction. (The purely functional obstructions from general peritonitis, the so-called "paralytic ileus," are not included in this group; see "Functional Obstructions.")

Early postoperative obstructions in the various Massachusetts General Hospital series have been, somewhat arbitrarily, defined as those occurring within the first four weeks after operation. As a matter of fact, the great majority of them occur in less than two weeks following operation, about half of those in the 1918–1927 series having taken place before the fourth day. The average time between the original operation and the operation for obstruction was about eleven days. Of the 335 cases of acute obstruction forming this series, early postoperative obstructions, as shown in Figure 2,* were responsible for 37 cases, or about 11 per cent of the total number.

Etiology and Pathology. As indicated by Table v early postoperative intestinal obstructions may complicate the convalescence from abdominal operations of any character, but are particularly likely to occur when peritonitis is present.

The adhesions responsible for these obstructions may be due to the mechanical trauma of operative procedures or to

* Figure 2 appeared in the first installment, January, 1933, p. 177.

TABLE V

EARLY POSTOPERATIVE OBSTRUCTIONS

(Third Massachusetts General Hospital Series)

Original Operation	*Number of Cases*
Appendectomy	35
(with drainage, 29)	
Pelvic Operations in Women	10
Operations for Carcinoma of the Rectum	7
Operations for Carcinoma of the Sigmoid	2
Resection of Jejunum and Closure of Gastroenterostomy Stoma	1
Closure of Perforated Gastric Ulcer	1
Repair of Ventral Hernia	1
Miscellaneous	9
Total	66

bacterial peritonitis. Any surface that has been denuded of its peritoneal covering is potentially a source of obstructive adhesions. A drain placed among the coils of the small intestine is a particularly common source of mischief.

The adhesions may be localized or widespread. Occasionally they may become surprisingly strong and abundant in a short period of time; but usually, due to their short duration, they are not firmly organized. They may bind a loop of bowel to the operative scar or to some inflamed structure in the pelvis, or to the posterior abdominal wall. They may act as a fixed point around which the bowel is twisted. When the obstructed loop lies in proximity to a localized septic process, as, for example, a tubo-ovarian or appendix abscess, the adhesions may be merely depositions of fibrin, glueing the intestinal coils together and causing localized kinks (Fig. 13) or valve-like closures. These might amount to little were it not for the distended, atonic condition of the bowel; but, as Cannon[2,3] has shown, in order to carry the intestinal contents beyond such an obstacle as a kink, it is necessary for peristalsis to be vigorous. Wilkie[4] also is convinced on the basis both of clinical and of experimental evidence that recent fibrinous adhesions and kinks may be an important factor in intestinal obstruction. Guiou[5] makes the point that the distention is also important, for as the diameter of the gut increases, acute

angulations and obstructive kinkings are more likely to occur. The frequency of acute angulations and adhesions of the terminal ileum following suppurative appendicitis has been

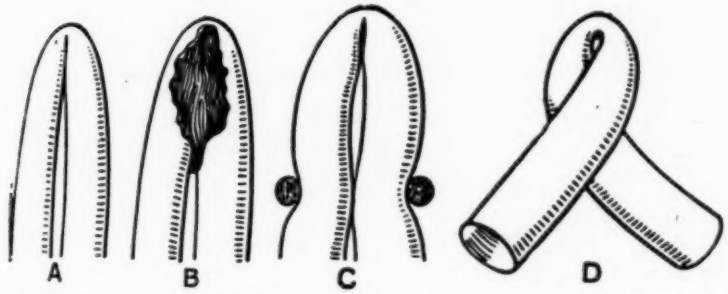

FIG. 13. Various forms of kinks: (A), free kink; (B), fixed kink; (C), held kink; (D), traction kink (garden hose kink, of doubtful occurrence in the intestine.) (From Guiou.[5])

stressed by Cheever,[6] Richardson,[7] and Roeder.[8]

Interference with the Circulation. Strangulations are not common among the early postoperative obstructions caused by recent inflammatory adhesions. Among 69 cases of obstruction occurring early after operation at the Massachusetts General Hospital during a twenty-year period, there were only 2 instances of strangulation by bands and 3 by volvulus. This is in striking contrast to the frequency of strangulation among late postoperative obstructions, where dense bands of scar tissue are so frequently responsible for the obstruction. Since strangulation is so seldom present in early postoperative cases, it is rare that bloody fluid is found in the peritoneal cavity; when this is present, strangulation must of course be suspected.

Level of the Obstruction. Most of the early postoperative obstructions occur in the lower portion of the small intestine. In about half of the cases in the foregoing series it was definitely stated that the obstruction was in the lower ileum. In 2 of the remaining cases it was said to be high in the small intestine (mid-jejunum); in 9 it was merely assigned to "the small intestine" without further specification; in 7 instances there

was no statement in the record by which the level could be estimated.

Age and Sex. Early postoperative obstruction occurs far more frequently in males than in females: in the Massachusetts General Hospital series there were 30 males and 7 females, a rather striking sex distribution.

Most of the cases occur between the ages of ten and fifty (see Fig. 3*). Appendicitis, the most common cause of these obstructions, is, of course, primarily a disease of early adult life.

Course of the Disease. The symptoms of obstruction shown by the early postoperative group are in general those of acute obstruction from any cause: vomiting, pain, distention and obstipation; but owing to the fact that these obstructions come on during a convalescence, the picture is often masked. If the histories of a number of these cases be studied, it will be found that the obstruction usually does not occur out of a clear sky: the onset is often insidious, the picture changing almost imperceptibly from that of a stormy convalescence with a considerable amount of vomiting and pain, (which, however, might be expected to quiet down under conservative treatment) to one where frank obstruction, demanding operative intervention, is recognized.

The picture is frequently complicated by varying degrees of peritonitis; in 12 of the 37 cases in the foregoing series this played a definite rôle. If peritonitis exists, it may be difficult to decide whether mechanical obstruction is present or whether there is simply a functional, paralytic condition of the bowel ("paralytic ileus"). Cramp-like pains and evidence either on inspection or auscultation of increased peristaltic activity are valuable signs pointing to the existence of a mechanical obstruction.

In another group of cases the early disturbance of the operation may have passed, the peritoneal infection have subsided and the convalescence be proceeding in a satisfactory

* Figure 3 appeared in the first installment, January, 1933, p. 180.

manner, when the first symptoms of obstruction manifest themselves, usually in from ten days to two weeks after the operation. The diagnosis is likely to be easier in this group.

Case III illustrates a number of points in relation to mechanical obstruction occurring in connection with peritonitis:

CASE III. *Appendectomy with drainage followed by early postoperative obstruction.*

No. 279,896, M.G.H. Female, aged thirty-two. Eight days before the operation for obstruction the patient entered the hospital complaining of pain in the abdomen of five days' duration. The pain had been almost constant and quite severe. During the two days before admission the patient had vomited a number of times. There had been no bowel movements for several days, although cathartics and enemas had been used. For the past twenty-four hours the patient had noticed distention of the abdomen.

On physical examination the patient appeared to be acutely ill, with marked distention of the abdomen. There was tympany over most of the abdomen, but dulness in the flanks. The temperature was 100°F., pulse 122, white blood count 4000. Lavage of the stomach yielded about 180 c.c. (6 oz.) of foul-smelling fluid. It was not at all clear whether the patient had organic obstruction or whether the symptoms were secondary to peritonitis.

First Operation. When the peritoneal cavity was opened a large amount of turbid fluid escaped. The intestines were everywhere distended and injected and showed depositions of fibrin. The appendix was found to be gangrenous and perforated. There was little or no walling off. The appendix was removed and a drain placed in the right iliac fossa and another in the pelvis. When the drain was inserted in the pelvis there was an escape of a considerable amount of foul-smelling pus. After operation the patient was placed in Fowler's position and was given morphine liberally. No fluids were given by mouth, but large quantities under the skin and by rectum.

On the first day after operation the patient was in poor condition, pulse barely palpable. On the second day her general condition showed some improvement: the abdominal distention continued, but there was no vomiting. For the next two days the condition remained about the same; but there was considerable vomiting. The stomach was washed out several times with a Levine tube, and the tube left in the stomach for twenty-four hours; there was profuse drainage.

During the course of the next four days the patient's condition showed improvement; and with this improvement there was a rise in white blood

count and temperature. The abdominal signs continued to be about the same, and frequent use of the stomach tube was required to prevent dilatation and vomiting.

On the eighth day postoperative, on passage of the stomach tube a large amount of foul-smelling fluid was obtained; the abdominal distention was a little more marked, and visible peristalsis was noted in the left upper quadrant. The patient complained of cramp-like abdominal pain.

Operation for Obstruction. Under local anesthesia a jejunostomy was performed by the Witzel method. At this operation no exploration was carried out. The coils of the intestine in the upper abdomen were distended, but no active peritonitis was present. The obstruction was presumably in the lower ileum in the region of the drains.

Following the jejunostomy, the patient showed marked improvement. There was profuse drainage from the catheter in the jejunum amounting to almost 4000 c.c. in twenty-four hours. This continued for a number of days, the lost fluid being adequately replaced by subcutaneous injections of normal saline solution. The patient's general condition showed steady improvement. The tube was removed from the jejunum eight days after the operation.

The patient was discharged in good condition thirty days after the second operation.

Comment. This case illustrates a number of points in the type of obstruction occurring early after operations undertaken for peritoneal infection. At the time of the first operation the patient was overwhelmed with the systemic effects of a general peritonitis, as shown by the high pulse rate, low temperature and subnormal white blood count. The intestinal symptoms during the early stages were undoubtedly those of functional disturbance of motility secondary to the peritonitis. During this stage the treatment was directed primarily toward localizing this infection (Fowler's position, morphine, fluid subcutaneously). The functional atony of the intestinal tract was marked; drainage back into the stomach was profuse, but use of the small stomach tube was considered adequate to cope with the situation.

About eight days following the appendectomy, the generalized bacterial peritonitis being for the most part overcome, there was an onset of mechanical obstruction, as indicated by visible peristalsis. This sign, taken in connection with the character and the increase in amount of the fluid obtained from the stomach, was deemed adequate indication for operative drainage of the intestinal tract. The symptoms of obstruction were completely relieved by a jejunostomy without exploration or attempt to break up adhesions; and, as so frequently happens with this type of obstruction, no further operative procedures were required: the light adhesions were

either completely absorbed, or the involved loop of bowel regained its tone so completely that those remaining were no longer capable of arresting the intestinal stream.

This case also illustrates the great loss of fluids that may take place. It is extremely important that careful study of intake and output of fluids and measurements of blood chlorides should be carried out on these cases in order that the water and the essential electrolytes, sodium and chloride, may be adequately replaced.

The history of Case IV illustrates instances where the obstructive adhesions are caused primarily by operative procedures rather than by peritonitis.

CASE IV. *Obstruction following exploratory laparotomy and appendectomy.* No. 288,275, M.G.H. Male, aged thirteen. The original operation was a laparotomy and exploration for repeated hemorrhages from the bowel. No neoplasm or other cause for the bleeding was found; the appendix, which was normal, was removed.

The patient made an uneventful convalescence until ten days after the operation, when he began to have sharp epigastric pain, and vomited. The signs of obstruction (pain, distention, vomiting, and failure to obtain results with enemas) persisted, and an exploration was decided upon.

At operation, the upper small intestine was found greatly dilated; the lower, collapsed. The omentum and two loops of small intestine were firmly adherent to the previous operative incision. There was also a rotation of the adherent loops around the point fixed by adhesions. The twist was straightened out and a jejunostomy was carried out by the Witzel method. A large amount of thin, fecal fluid was immediately evacuated through the catheter.

The first few days' convalescence was stormy; and large amounts of intravenous and subcutaneous fluid were required to combat dehydration. The symptoms of obstruction subsided and the patient was discharged symptom-free about three weeks later.

Comment. The obstruction in this case was due to adhesions resulting from operative trauma to the peritoneum. There was no acute peritonitis with the functional element that it so often carries. Note that the obstruction came on relatively late after the operation with a sudden onset and the classical signs of acute obstruction. The diagnosis is often much easier in this type of obstruction occurring after operation than in cases such as that quoted above where active peritonitis confuses the picture.

Obstructions early after operation may also arise as a result of operative procedures which alter the normal relations

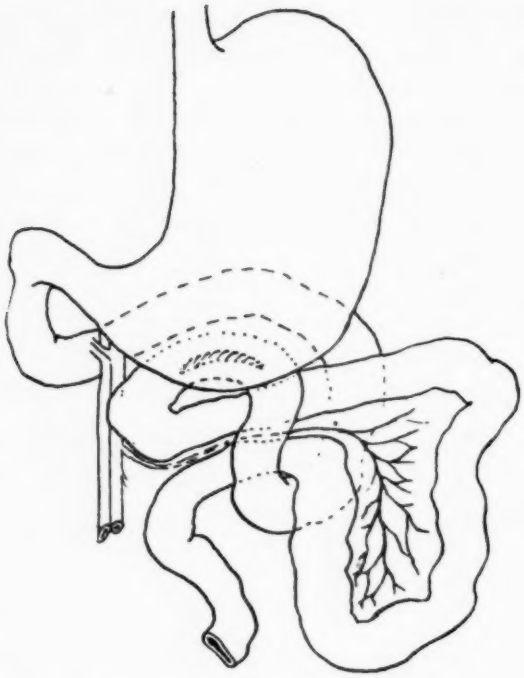

FIG. 14. Strangulation occurring after a posterior gastroenterostomy. (From Keene.[9])

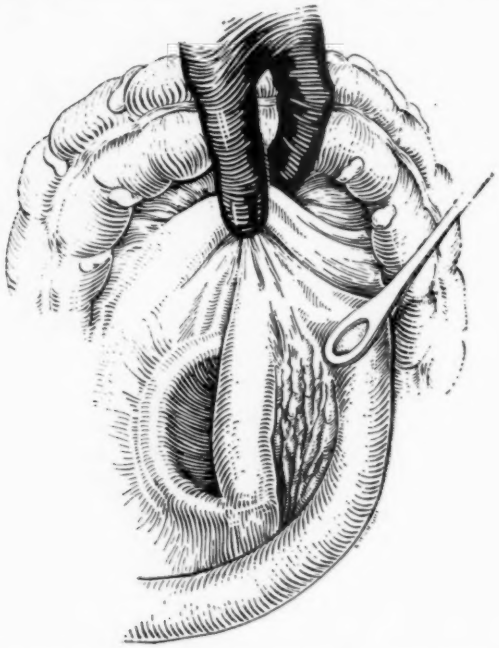

FIG. 15. Boundaries of opening through which herniation may occur following a posterior gastroenterostomy. (From Armitage.[10])

of the intestinal tract: anastomoses, enterostomies, colostomies and the like may result in abnormal apertures or arches through which the bowel may herniate and become obstructed (Figs.

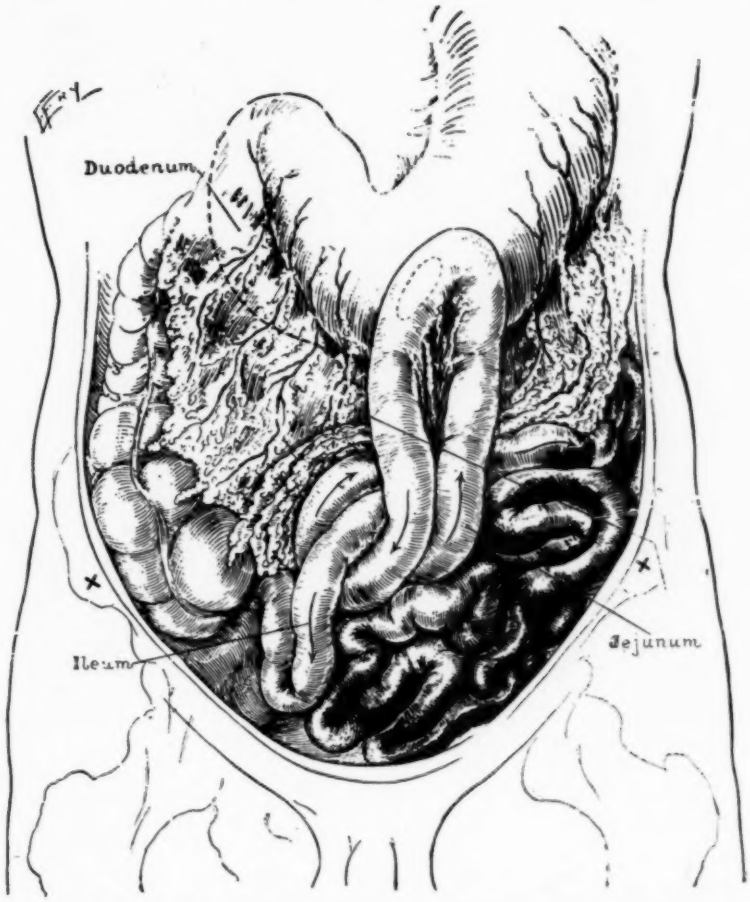

FIG. 16. Hernia of small intestine behind short anastomotic loop of jejunum following posterior gastrojejunostomy. (From Mayo and Magoun.[11])

14 and 15). Case v illustrates obstruction following a colostomy.

CASE V. *Obstruction following operation for cancer of rectum.*

No. 245,924, M.G.H. Male, aged forty-three. Amputation of the rectum for carcinoma was performed, combined abdominal and perineal, one stage.

On the second day postoperative the abdomen was somewhat distended and the patient was hiccoughing. One day later, the colostomy was opened,

with some immediate relief. The distention, however, increased and no result was obtained from an enema. "Fecal" vomiting occurred. The stomach was washed out and a moderate amount of foul-smelling fluid

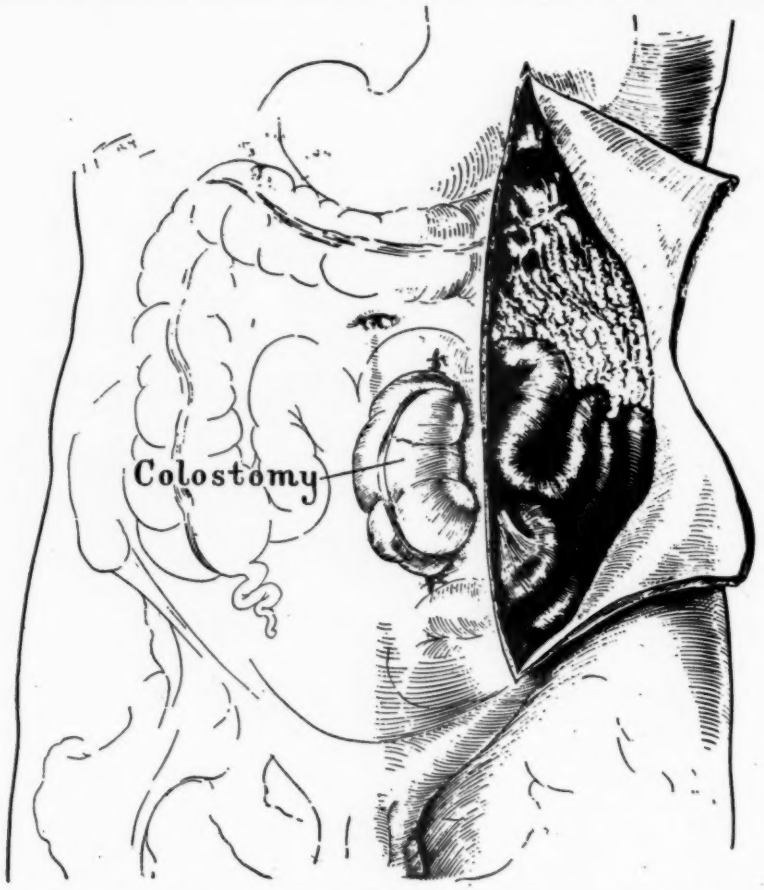

FIG. 17. Hernia of small intestine around colostomy. To prevent the type of hernia shown in this illustration Mayo suggests placing the colostomy far to the left of the midline. After the loop of sigmoid has been brought out of the abdomen the mesocolon is sutured to the left parietal peritoneum by a continuous puckering suture. Two interrupted sutures are then placed at the juncture of the sigmoid and its mesentery just below the outer cut edge of peritoneum as shown in Figure 18. (From Mayo and Magoun.[11])

obtained. During the next two days some gas was expelled through the colostomy, but distention persisted and the patient's general condition was not satisfactory; vomiting recurred.

Six days after the original operation an exploratory procedure was carried out. It was found that an obstruction was present, caused by coils

of small intestine passing between the attachment of the colostomy and the left abdominal wall. As the distention had increased, the obstruction had become complete. The intestines were restored to their normal position,

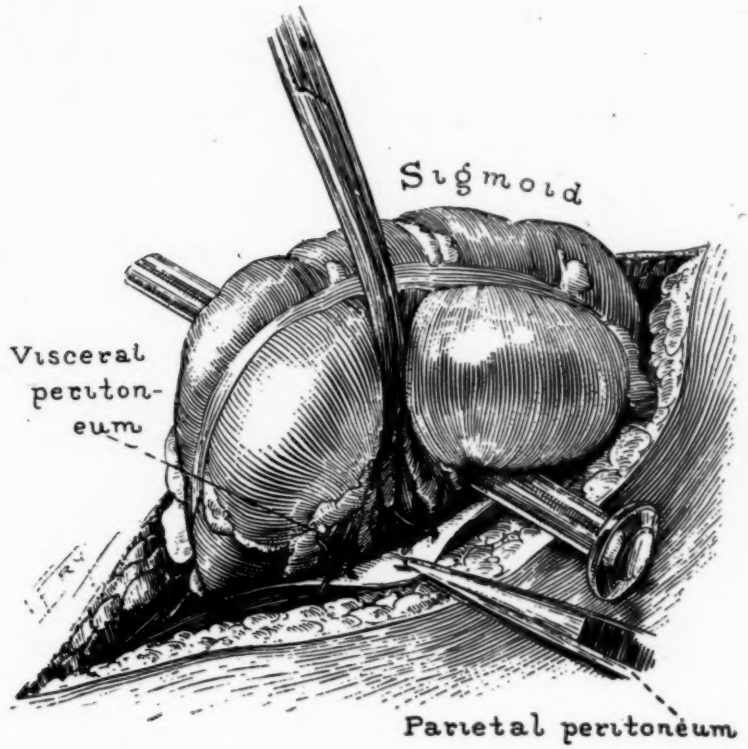

FIG. 18. Two interrupted sutures through cut edge of parietal peritoneum and upper portion of mesosigmoid to prevent retraction of the colostomy loop. (From Mayo and Magoun.[11])

and an ileostomy was performed.

The patient was in poor condition after the operation and died fifteen hours later.

Comment. The obstruction did not result from injury to the peritoneum either by bacterial peritonitis or by operative trauma, but from what was essentially an internal hernia. Dr. D. F. Jones now advises fixation of the colon to the left abdominal wall so that it is not possible for a loop to herniate through this opening.

Case VI illustrates a rather rare type of obstruction coming on early after operation:

CASE VI. *Volvulus occurring early after operation.*

No. 259,416, M.G.H. Female, aged twenty-six. The first operation was for subacute appendicitis. The appendix was removed and the abdomen closed without drainage.

On the second day postoperative the note states that the abdomen was somewhat distended. The fourth day after operation there was further distention, a sudden onset of violent epigastric pain, and vomiting. The stomach was washed out and an enema given with some relief. Some time after the onset of the epigastric pain an indefinite, soft mass was made out in the right lower quadrant of the abdomen.

On the fifth day after operation the symptoms of obstruction were so pronounced that the patient was again operated upon. A volvulus of the cecum was found, the terminal 6 inches of the ileum and the ascending colon being involved in the twist. The volvulus was reduced and a cecostomy performed. The patient made an uneventful convalescence.

Keene,[9] Armitage,[10] and Mayo[11] have reported cases* where following a posterior gastroenterostomy the small bowel herniated through the opening formed by the transverse mesocolon, the posterior abdominal wall and the loop of intestine lying between the ligament of Treitz and the gastroenterostomy (see Fig. 14). Molesworth[12] has described a somewhat similar condition occurring after an ileocolostomy†: here the bowel herniated through a ring bounded in front by the anastomosis, above by the transverse mesocolon, behind by the posterior abdominal wall, and below by the mesentery of the small intestine. Mayo and Magoun's article[11] on the internal hernias that occur as a result of operative procedures is very interesting and comprehensive.

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* These cases occurred late after operation; but I have observed a case where the same thing occurred during convalescence.

† This case also actually occurred late after operation, but might well have occurred early after operation.

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Chapter V

VARIETIES OF OBSTRUCTION (Continued)

Obstruction by Volvulus

Intestinal obstructions produced by the rotation or twist of an intestinal loop form an interesting though relatively rare group.* The underlying cause of the volvulus may be some congenital anomaly, such as abnormalities in the fetal rotation of the gut, or lack of mesenteric or cecal fixation.[1,2] A giant sigmoid or a megacolon may be the predisposing factor: Weeks[3] has collected 63 such cases from the literature. In another group of cases, bands and adhesions, tumors of the mesentery, etc., may be the etiological factors. A volvulus may occur in association with a hernia.[4]

Either the large or the small intestine may be obstructed by this mechanism. In the large intestine the most common sites are the sigmoid flexure and the cecum. Due to their close anatomical relation, a volvulus of the cecum may involve the ascending colon and terminal ileum. A mobile cecum or sigmoid may become twined around a coil of ileum, or may serve as an axis around which a section of small intestine may become coiled; these cases are extremely rare, but have been reported by Treves,[5] Leichtenstern,[6] Wilms,[7] and others.

When a section of gut undergoes rotation around its mesenteric axis, or in some instances around its own long axis, an isolated loop is formed (see Fig. 19) with obstruction of the lumen at both ends. There is also more or less compression of the mesenteric vessels, particularly of the thin-walled veins. The amount of the interference with the mesenteric circulation may vary from slight congestion to complete venous blockage, depending upon the degree of rotation and the tightness of the

* Minor degrees of torsion of intestinal loops are often found when strangulation by a band occurs. The term "volvulus" is usually reserved for the more extreme twists and rotations.

twist. It is frequently severe. The obstructed loop may also become enormously distended, which further embarrasses its blood supply. Due to the twofold interference with the circu-

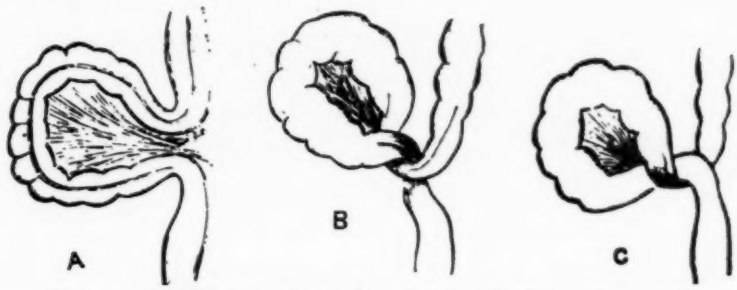

FIG. 19. Mechanism of volvulus of sigmoid. (From Treves .[9])

lation, through pressure on the mesenteric vessels and from gaseous distention within, changes in the bowel wall often occur early and may proceed to complete infarction and gangrene, with resulting peritonitis. In the 1918–1927 Massachusetts General Hospital series, 9 of the 15 cases of volvulus showed serious interference with circulation; in 5 instances, changes in the bowel wall were so extensive as to require resection.

Cases of volvulus are usually grouped under three heads: volvulus of the sigmoid; volvulus of the cecum; and volvulus of the small intestine.

VOLVULUS OF THE SIGMOID. According to the figures of Braun and Wortmann,[8] volvulus of the sigmoid flexure occurs almost three times as frequently as that involving the cecum and ascending colon; although in the cases of volvulus in the recent Massachusetts General Hospital series the numbers found in these two locations were equal.

Volvulus of the sigmoid takes place by rotation of the loop around its mesenteric axis (Fig. 19); for its occurrence it is of course necessary to have a mobile loop of sigmoid. There are many theories as to the inciting cause; undoubtedly it differs in different cases. At times adhesions which bind parts of the redundant loop together in a distorted position or fasten portions of the loop to the pelvis or descending colon undoubtedly

play a part. Bloodgood[10] believes that gaseous distention of such an adherent loop is an important factor in producing the twist: as the distention increases, the expanding bowel exerts traction on the mesentery and the twist is drawn tighter. A congenital enlargement of the sigmoid is sometimes found in association with volvulus,[3,11] and may be responsible for its occurrence. Treves[12] considers that obstinate constipation in elderly patients is an important etiological factor; on the other hand, there have been cases that have followed shortly after a diarrhea. It has been stated that overeating after a long fast predisposes to volvulus of the sigmoid; and that this type of obstruction was of not infrequent occurrence in Old Russia where a period of feasting often followed a long period of fasting.[13]

Clinical and Pathological Features. The disease may occur at any age; but it is more common after middle life. The onset may be accompanied by severe pain and vomiting. The pain is likely to be located in the left lower quadrant with radiation across the lower abdomen; it may be of sufficient severity to produce collapse. There is usually nausea and vomiting. Obstipation is complete; and enemas are without result. The severity of the symptoms are in general in proportion to the degree of interference with the circulation. There is often an elevation in the white blood count, with an increased proportion of polymorphonuclear leucocytes.

There may be a history of habitual constipation, and the patient may have experienced in the past similar attacks of pain that were relieved by enemas.[10] Volvulus of the sigmoid may complicate the convalescence from an abdominal operation.[10,14] On physical examination, marked distention of the abdomen may be a striking feature. Frequently there is localized tenderness and spasm in the lower left abdomen, and occasionally a mass may be made out in this region.

The history of Case VII illustrates some of the features of the disease:

CASE VII. *Obstruction by volvulus.*

No. 275,846, M.G.H. Female, aged thirty-eight. Patient had been troubled by obstinate constipation for two weeks. About twenty-four hours before admission she was taken with severe colicky pain, located in the left lower quadrant of the abdomen. The pain had been increasing in severity. Enemas had been given without results. Abdominal distention had increased rapidly.

On physical examination the abdomen was found distended and tympanitic; it was tender in the left lower quadrant, where a well-defined, soft tumor 4 or 5 inches in diameter could be made out. During a paroxysm of pain this tumor became hard and more prominent.

At operation a volvulus of a redundant sigmoid was found. The volvulus was untwisted with some difficulty. The bowel was evidently viable.

The convalescence was uneventful. Three years later the patient entered the hospital and a hernia in the operative wound was repaired. There had been no recurrence of the symptoms.

At times the degree of distention of the sigmoid is enormous, the loop occupying practically the whole abdominal cavity and causing embarrassing pressure on the diaphragm.

VOLVULUS OF THE CECUM AND ASCENDING COLON. While volvulus of the sigmoid always takes place around the mesenteric axis, volvulus of the cecum may occur in a number of different ways. It may occur around a line which is at right angles to the long axis of the cecum: in other words, the cecum may be bent back upon itself so that the lower part of its posterior surface becomes the anterior and lies with the appendix along the ascending colon. Or it may be rotated or twisted clockwise on its own long axis. There are, however, cases in which the cecum and ascending colon are provided with a long mesocolon which allows the coil to be twisted on its mesenteric axis just as in the case of the sigmoid; and at times, a redundant loop of cecum and ascending colon may become intertwined around some coil of small intestine or may serve as an axis around which small intestine is coiled.[5]

Most cases of volvulus of the cecum depend fundamentally upon some congenital anomaly associated with developmental defects in rotation of the colon.[2,5] Homans[15] has reported cases

illustrating different types of developmental anomalies of the cecum that were responsible for volvulus.

The cecum is capable of great distention and in cases of

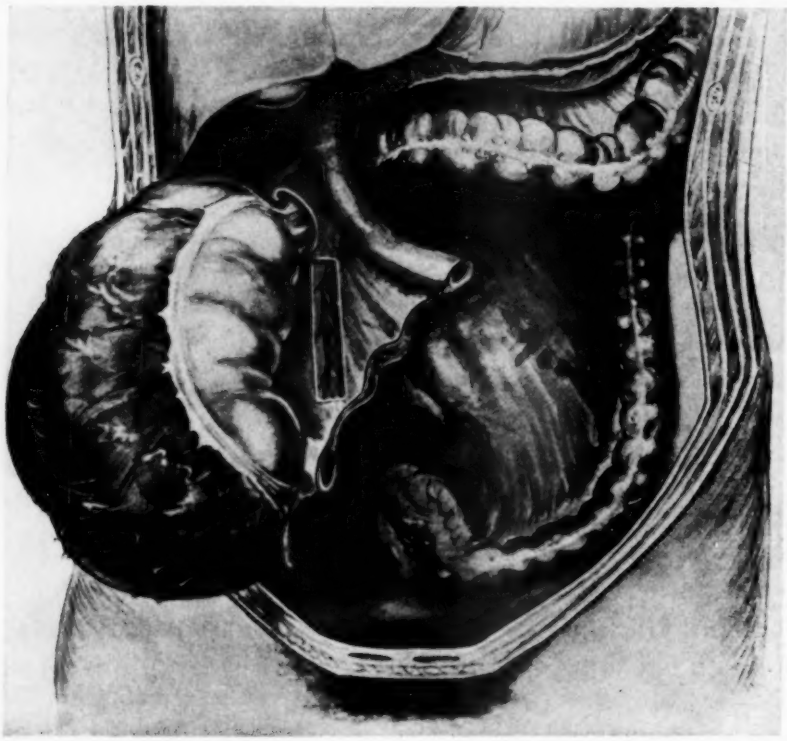

FIG. 20. Volvulus of cecum in association with malrotation. Note that peritoneal coat of cecum has ruptured from distention. (From Dott.[2])

volvulus may reach an enormous size. In one of Kirby's cases[16] it measured 45 cm. long by 30 cm. in diameter.

Rarely, volvulus of the cecum may occur during the convalescence from an abdominal operation.[17]

CASE VIII. *Obstruction by volvulus of the cecum.*

No. 245,586, M.G.H. Female, aged nineteen. The patient entered the hospital thirty hours after the onset of the attack. The day before admission she had "attended a fair at school and had eaten heavily of a number of things." After a few hours' abdominal discomfort, the patient had been taken with severe pain, which was described as dull in character. There was vomiting at the onset of the pain, and this had been repeated a number

of times; the vomitus was watery and greenish. Enemas had been given without result. The abdominal distention had been increasing.

On examination the patient appeared acutely ill. There was enormous

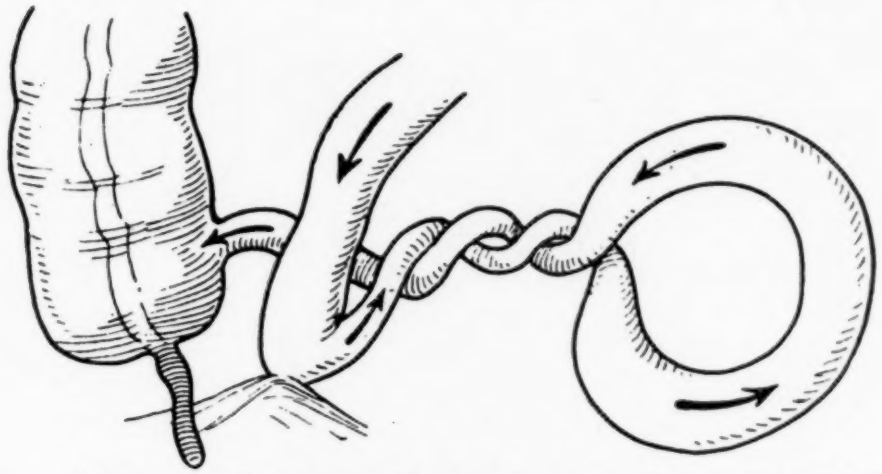

FIG. 21. Volvulus of small intestine resulting from fixation by adhesions. (After Göbell; see Braun and Wortmann.[19])

distention of the abdomen, marked tenderness and muscle spasm in the right lower quadrant. There was a questionable mass occupying the right lower side of the abdomen. Temperature 99.4°F.; pulse 132.

An exploratory operation was carried out, and bloody fluid with a foul odor was found in the peritoneal cavity. A volvulus of the cecum and ascending colon was found. There was a long mesocolon, and the cecum and ascending colon had made one complete twist on the mesentery. The cecum was greatly distended, and was black and gangrenous in appearance. The gangrenous mass was delivered and a catheter was sewn into the terminal ileum. The patient was in poor condition at the termination of the operation, and died eight hours later.

VOLVULUS OF THE SMALL INTESTINE. Volvulus of the small intestine may occur anywhere from the jejunum to the terminal ileum, the more common location being in the lower portion of the ileum. One or more loops may be involved. Rarely the torsion may involve the whole mesentery of the small intestine; Weible[18] was able to collect 65 such cases from the literature.

Fixation or distortion of the mesentery by bands and adhesions is probably the most frequent cause of volvulus of the small intestine (Fig. 21). At times mesenteric lymph

glands or mesenteric cysts may be etiological factors. The occurrence of volvulus may complicate the convalescence from an abdominal operation. This occurred in 3 instances in the

FIG. 22. Volvulus neonatorum, showing dilatation of duodenum and stomach above point of constriction. (From Dott.[20])

Massachusetts General Hospital series; in two of these cases the small intestine was involved, in one the cecum. There were 2 cases of volvulus in this series in which no previous operation had been carried out. The operative notes upon one of these cases showed that the mesentery was very long and that the intestine was adherent in the pelvis. In the other case a complete twist of the mesentery of the small intestine had taken place in a girl aged sixteen years; after the volvulus was untwisted, the bowel had seemed to be viable, but thrombosis of the mesenteric veins set in and the patient died about forty-eight hours later, the autopsy showing thrombosis of the mesenteric vessels with complete infarction of the small intestine.

The clinical course of obstruction of the small intestine by volvulus does not, in general, differ from that in other cases where strangulation of the small intestine is present.

VOLVULUS NEONATORUM. Dott[2] has drawn attention to a variety of volvulus occurring in the newborn, which he calls "volvulus neonatorum." The child often appears normal for a few days and meconium is passed. With the onset of the volvulus, vomiting sets in; the vomitus is deeply bile-stained. The upper half of the abdomen only is distended: since there is obstruction only at the upper extremity of the twisted gut, and free exit through the colon below, the lower bowel does not become distended (Fig. 22). Melena may or may not be evident. More recently, Dott reported a case[20] where the lesion was diagnosed and successfully operated upon. Rixford's case[1] where this type of lesion was found in a five-year-old child is of interest. Donald[21] has reported a somewhat similar case in an adult.

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Chapter VI

Varieties of Obstruction (Continued)

Obstruction by Intussusception

Definition. By the term intussusception is meant the invagination of one segment of the intestines into another. It is an important and serious cause of acute obstruction of the intestine. Its relative frequency in various clinics is shown in Figure 2 and Table 1.* Since this disease is commonly one of infancy and early childhood, the frequency of its occurrence in relation to other types of acute obstruction in any particular clinic depends upon the ratio of children to adults admitted. Thus, in the figures of Ladd and Cutler[1] from the Children's Hospital, Boston, out of 102 cases, including all varieties of acute obstruction, intussusception was responsible for the obstruction in 88 cases (86 per cent). Peterson's[2] figures, also based on the occurrence of acute obstruction in infancy and childhood, show about the same relative frequency of obstruction from intussusception to obstruction from other causes.

The anatomy of an intussusception forms an interesting picture, the details of which are shown in Figure 23. The common terms used in describing an intussusception are also shown in this diagram: the outer layer is known as the "sheath" or "receiving layer," or "intussuscipiens"; the invaginated portion is known as the "intussusceptum," and is composed of two layers, the entering and the returning; between these layers is found the mesentery and at times mesenteric glands or the appendix. The most advanced portion of the intussusceptum is the "apex" of the intussusception, the point of entrance of the intussusceptum is the "neck." The entering and returning layers have their serous surfaces in apposition; the returning layer and the sheath have their mucosas apposed. Although the

* Figure 2 and Table 1 appeared in the first installment, January, 1933, pp. 177 and 178 respectively.

facts are well known, a great many diagrams that illustrate the anatomy frequently do not stress the most characteristic and important feature, namely, the fact that not only is one segment

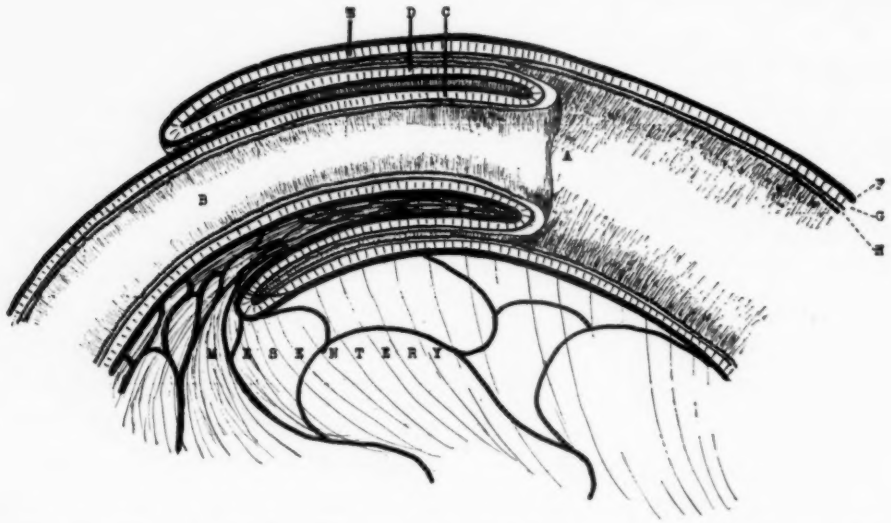

FIG. 23. Diagram showing different parts of an intussusception. Sheath or receiving layer is known as intussuscipiens; swallowed portion is intussusceptum. Note compression of mesentery between layers. (A), Apex of intussusceptum. (B), Neck of intussusceptum. (C), Entering layer of intussusceptum. (D), Returning layer of intussusceptum. (E), Intussuscipiens. (F), Peritoneum. (G), Muscularis. (H), Mucosa.

of the bowel telescoped into another, but the entering or "swallowed" portion consists not only of bowel wall but also of mesentery. This vital structure is caught between the entering and returning layers (see Fig. 23) and forms a somewhat wedge-shaped mass with its apex attached to the most distal point of the intussusception and its base lying at the neck of the intussusception. It is obvious that as the intussusception increases, the mesentery will be put more and more on the stretch, and will be more and more compressed at the neck. The pull of the mesentery gives the characteristic curved shape to the intussusception.

There are occasional cases in which the invagination is not single, but compound; it may be double or triple; the latter condition is very rare. In these cases there is first a primary

single invagination, such as is shown in the diagram, and then secondary invaginations which occur around the first. Cases have also been reported where two or more invaginations occurred simultaneously in different portions of the intestinal tract.[3]

Another rare form is the so-called "retrograde" intussusception. In the common forms of intussusception the invagination occurs in a descending direction: in other words, the apex points downward in the intestinal canal. In retrograde intussusceptions the apex points upward; the intussusception having occurred in an ascending direction. According to Treves,[4] a primary descending intussusception may be associated with a secondary ascending or retrograde intussusception. Cases of retrograde gastrojejunal[5] intussusceptions have been reported following posterior gastroenterostomy.

Intussusceptions are frequently found at autopsy that have evidently occurred only a short time before death, and for this reason are called "agonic" intussusceptions. They are small, and show no evidence of congestion or inflammation. They are probably associated with the violent spasmodic contractions and violent peristalsis that are commonly encountered if the blood supply is cut off from the intestines.[6] According to many writers they are most commonly met with in children who have died of some disease of the central nervous system. They are often multiple and frequently of the ascending or retrograde type. They are, of course, of no clinical significance; and the only point is to make a correct diagnosis of the condition at autopsy.

Varities of Intussusception. Intussusceptions are of three major varieties, the classification being made on an anatomical basis. The terminology which was generally accepted until 1873, and which is still the simplest, describes as "enteric" those cases in which the small intestine alone is involved; as "colic" those in which invagination of the colon alone occurs; and as "ileocecal" all cases of intussusception in which the terminal ileum and cecum are involved.

Enteric Intussusceptions. Enteric intussusceptions, those in which the invagination involves the small intestine alone, form a relatively small group (about 10 to 15 per cent[7,8]); but since this group occurs chiefly in older children and adults, the exact percentage would depend on the ratio of infants to older individuals admitted to any given clinic.[8] An obvious organic lesion is often responsible for the intussusception; among the inciting causes may be mentioned Meckel's diverticulum, a polyp, carcinoma, hemangio-endothelioma, tuberculous ulceration[9] and possibly an inflamed Peyer's patch. Watts stressed the importance of adenomata.[10]

Colic Intussusceptions. Colic intussusceptions, those involving the colon only, constitute about 6 per cent of all cases of intussusception. In those occurring in early life, Perrin and Lindsay[7] stress the importance of mucosal folds and lymphoid follicles as etiological factors. In the colic intussusceptions of adult life, just as in the enteric intussusceptions, some type of tumor is ordinarily responsible. Chronic intussusceptions having carcinoma as a basis occur not infrequently.

Intussusceptions Involving the Terminal Ileum, Cecum and Colon. There is hopeless confusion in the terminology at present used for the large and important group of intussusceptions involving the terminal ileum, cecum and colon. This is due in part to the fact that a vast number of terms have been created to describe differences in the starting-point or method of growth of these intussusceptions, and writers have used dissimilar terms to describe similar varieties, and similar terms to describe dissimilar varieties. Another factor that has led to confusion is that, even granting a uniform use of terms, it is often difficult, or impossible, at operation to identify accurately the anatomical points that serve as a basis for classification; and the distinguishing features are often lost in the process of reduction. It is thus hard to be sure in which group a given intussusception involving the terminal ileum and cecum should be classified. It is suggestive in this connection

that in studying 363 cases of intussusception Close[11] found a statement as to the type in only 185 instances.

In examining the literature we find that most writers divide

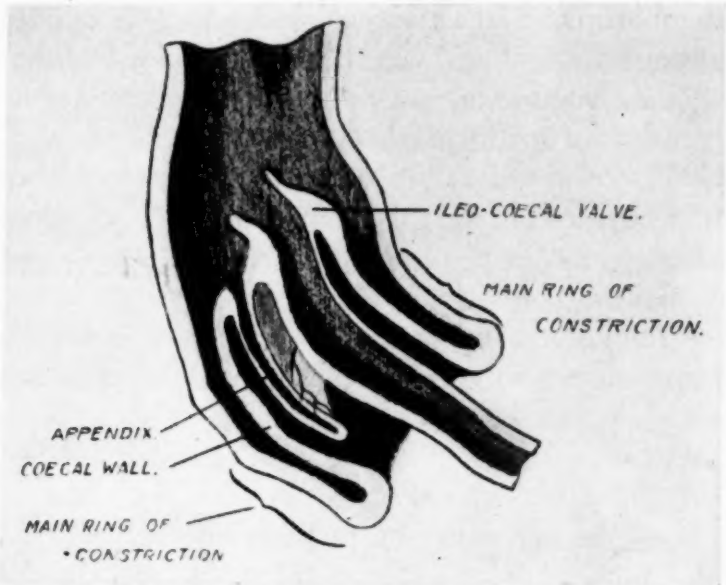

FIG. 24. Ileocecal intussusception. Ileocecal valve heads intussusception. Cecal wall lying next to appendix will, after reduction, often present a characteristic "dimpled" appearance due to edema and congestion. Note "main ring of constriction." (From Perrin and Lindsay.[7])

the old form "ileocecal" into two main groups: ileocecal and ileocolic. There is general agreement that the first of these groups, the ileocecal, should include those intussusceptions where the ileocecal valve forms the apex of the intussusception* (see Fig. 24). There is good reason for also including as ileocecal those cases formerly classified as "caput-ceci," "cecocolic" and "ileocecal-caput-ceci," where the base of the cecum was supposed to form the apex of the intussusception.†

* Corner[12] considers this variety very rare, while Perrin and Lindsay feel that it makes up about 46 per cent of all intussusceptions.

† It has been noted for a long time that after an intussusception involving the terminal ileum and cecum had been reduced a dimpling of the cecum was often present. This was considered by certain authors to indicate that the head of the cecum had formed the apex of the intussusception and they therefore gave to cases in which this occurred the special names "cecocolic," "caput-ceci" and "ileocecal-caput-ceci." Fitzwilliams

The term used for the second subdivision of the old form "ileocecal intussusception," namely, "ileocolic," has given rise to considerable confusion. Leichtenstern,[13] who originated the term, defined this type of intussusception as "a prolapse of the ileum through the ileocecal valve"; Fitzwilliams,[3] and Perrin and Lindsay,[7] doubt whether a prolapse ever takes place, believing that what really occurs is the passage through the ileocecal valve of an intussusception that has started in the ileumc lose to the valve.* (See Fig. 25.) Treves[14] and Leichtenstern recognized that this latter method of invagination occurred at times and designated it as "iliaca-ileo-colica" intussusception.

There remains to be described one other not uncommon form of intussusception occurring in the region of the terminal ileum and involving the cecum and colon. In this type the intussusception forms in the terminal ileum, usually within 12 inches of the ileocecal valve, passes down to the ileocecal valve and enters the colon by pushing the valve before it, at times becoming impacted in the valve. During the reduction of this type of intussusception, when the cecum is completely emptied, an enteric intussusception is found. Clubbe[15] places this form in his "enterocolic" group†; Perrin and Lindsay prefer to classify it as a "compound" intussusception and consider that it is much more frequent than is generally

and Perrin and Lindsay consider that the dimpling is not to be interpreted in this way but that it is a secondary feature, caused by pressure and edema, the ileocecal valve having really formed the head of the intussusception. They therefore include these varieties among their ileocecal intussusceptions and urge that the terms cecocolic, caputceci and ileocecal-caput-ceci be abandoned. Even granting that in certain instances the end of the cecum may form the apex of the intussusception, this probably occurs very seldom; and considering the close proximity of the ileocecal valve to the end of the cecum, the present writer feels that for the sake of simplicity these intussusceptions had best be grouped as ileocecal.

Cases have been reported in which there first occurred an invagination of the appendix into the cecum, followed by an invagination of the base of the cecum.[12]

* It will be noted in the illustration that if the intussusception were seen after the enteric intussusception had unfolded itself into the cecum, it would be impossible to tell whether or not it had started as a prolapse. Fitzwilliams contends that it does not.

† Clubbe has no group called ileocolic; but includes the ileocolic of Perrin and Lindsay as a subdivision of his "enterocolic."

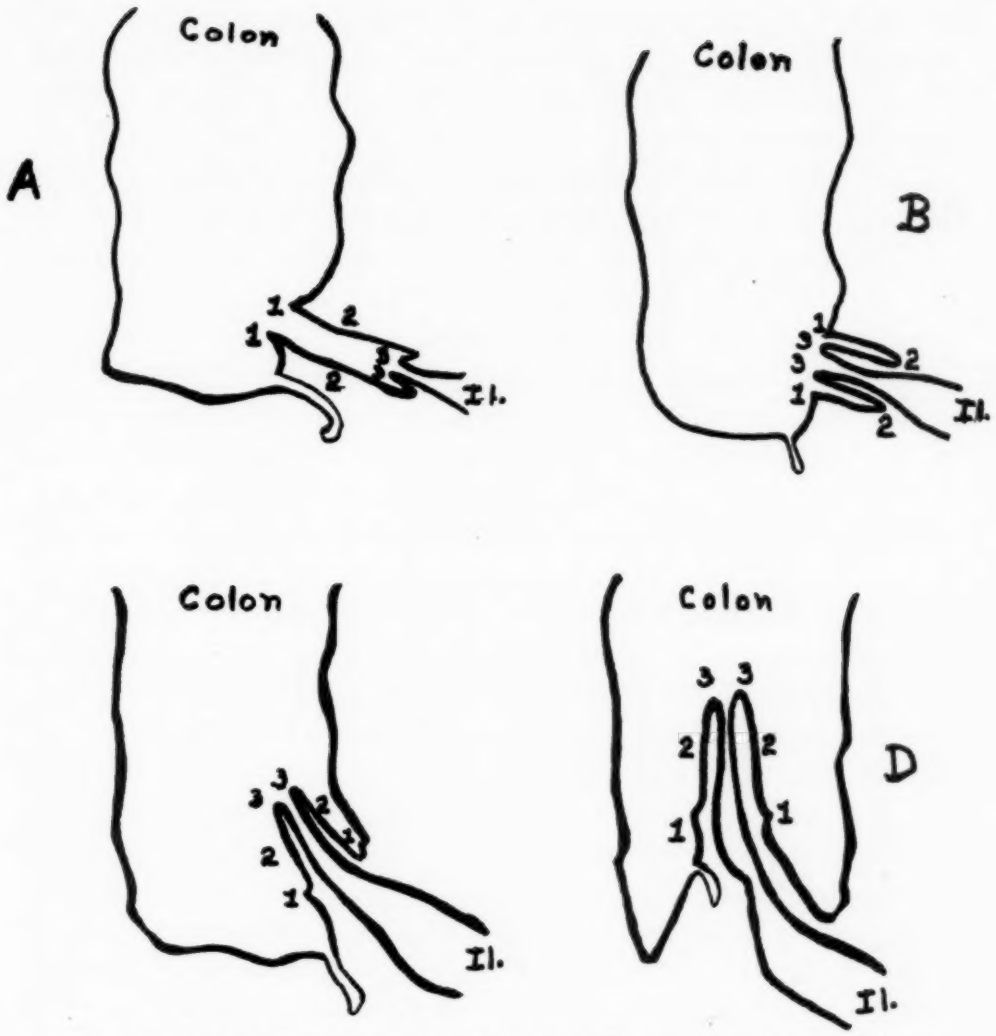

FIG. 25. Mechanism of formation of an ileocolic intussusception according to Fitzwilliams. Numbers denote fixed points on ileum. (A), an enteric invagination starting at 3. (B), 3 remaining the apex passes through valve, while 2 rolls round at neck from *outer* to *middle* layer. (C), all ileum of sheath has now passed round neck into middle layer. (D), growth proceeding, valve, cecum, and colon roll round into middle layer. As in all other forms of intussusception, apex has remained constant. (After Fitzwilliams.[3])

realized; Corner describes it as "enteric ileocecal." Since it is closely related to the ileocolic, and to distinguish it from other compound intussusceptions, I propose calling it "compound ileocolic."*

In summary, the following classification, which closely corresponds with Perrin and Lindsay's, is recommended:

Ileocecal: Forms in which the ileocecal valve heads the intussusception. This term includes the so-called "cecocolic," "caput-ceci" and "ileocecal-caput-ceci."

Ileocolic: Forms in which the ileum is found within the cecum but the valve does not form the apex. This condition may come about as a result of an intussusception forming in the terminal ileum close to the valve and passing through the valve (see Fig. 25). It is a disputed point whether an ileocolic intussusception may also come about, rarely, as a prolapse of the ileum through the valve.

Compound Ileocolic: Cases in which an enteric intussusception starting in the ileum about 12 inches from the ileocecal valve enters the colon by pushing the valve before it, at times becoming impacted in the valve.

The great majority of intussusceptions involving the terminal ileum and cecum occur in infancy and early childhood. Usually no organic pathology can be demonstrated as responsible for these intussusceptions, unless the view of Perrin and Lindsay, and others, be accepted, that hypertrophy of the lymphoid tissue is commonly present.

Mechanism of the Invagination. The questions of how and why invaginations of the intestines take place have interested investigators for a long time. A great many theories or speculations have been advanced to account for the phenomena, and all points are not yet clear. There are, however, certain facts that must be taken into consideration.

* There are other types of compound intussusception that may occur in the region of the ileocecal valve. For example, Perrin and Lindsay quote a case in which the intussusception started as an ileocolic intussusception and when 9 inches of the ileum had passed through the ileocecal valve the colon was invaginated into itself.

In the first place, one must assume a perverted action of the normal peristalsis. It is in attempting to explain the underlying cause of these abnormal intestinal movements and the exact form that they take that conflicting theories arise.

The modern view inclines toward the belief that there is an organic basis for the abnormal intestinal movements in the great majority of cases;[7] it is a well-known fact, for example, that intussusceptions frequently occur in connection with tumors which may be polyps, carcinomas, Meckel's diverticuli, submucous angiomas and so forth, attached to the internal wall of the bowel. It has been suggested[7] that some intussusceptions which have heretofore been considered purely functional may have an organic basis in the presence of hypertrophied lymphoid tissue, particularly around the ileocecal valve and terminal ileum.

There is, however, a group of intussusceptions for which no organic basis can be found. Surgeons have observed that minor degrees of intussusception take place and reduce themselves in the course of operations. Also minor degrees of invagination are easy to produce in animals and often occur spontaneously (Treves[16] and Alvarez[17]).

Meckel's diverticulum, which so frequently furnishes the organic basis for an enteric intussusception (occurring in almost half the total cases analyzed by McIver[8] in which organic pathology was responsible for the intussusception; see also Hertzler and Gibson[18] and Lower[19]) may be used as a representative of the type of intussusception brought on by a tumor or polyp attached to the bowel wall. Figure 26 shows the relation, in an illustrative case, of the diverticulum to the intussusception. It will be noted in the first place that the diverticulum is inverted into the lumen of the intestine. In regard to this point, cases of intussusception associated with a diverticulum have been reported (Porter[20]) in which there was no inversion of the diverticulum; but in the great majority of cases (including all of Hertzler and Gibson's[18]) inversion of the Meckel's diverticulum into the lumen of the gut is present.

These latter writers consider that the inversion occurs as a secondary process; but this seems most unlikely. To most authors the inversion has seemed to be a very important

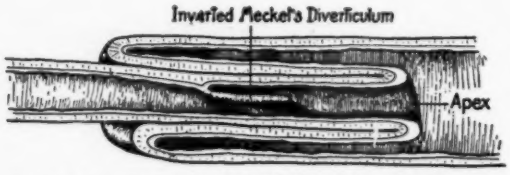

FIG. 26. Intussusception caused by Meckel's Diverticulum. A specimen found at operation, shown in diagrammatic form. The Meckel's diverticulum was inverted in the lumen of the gut. It will be noted that the diverticulum did not form the apex of the intussusceptum, but was attached near the proximal end. (From McIver.[8])

factor in the later production of the intussusception, and numerous speculations have been indulged in as to the method of its occurrence. Two theories stand out as being most plausible. The first is that an active peristalsis of the walls of the diverticulum in an effort to expel its contents brings about the inversion. The second, which has received considerable attention, is that an inflammatory process occurs around the opening of the diverticulum into the lumen of the intestine, producing a thickening of the walls of the diverticulum, and that this process extends until the mucous membrane protrudes into the lumen of the intestine where it is caught up and pushed along by the intestinal peristalsis.

In regard to the second point, namely the manner in which the intussusception is produced, it may be said that the mechanism is probably the same whether the foreign body attached to the intestinal wall be an inverted Meckel's diverticulum, an adenoma or a single polypus. An explanation commonly offered is that the diverticulum or other tumor is dragged along by the peristaltic movements of the intestine, the point of attachment being thereby invaginated and forming the apex of the intussusception. Wardill[21] discusses this point (with reference to the intussusceptions caused by polypoid growths in general) and points out the fact that this theory cannot be upheld since in a number of cases the polypus does

not form the apex. He believes the true explanation to be that there is a spasmodic contraction of the gut around the polypus and an inhibition of the part immediately distal to this; his article carries illustrations of this point. It is probable that some such mechanism is often responsible for the intussusception. In some of the cases reported in the literature (Porter[20]), however, the inverted diverticulum does occur at the apex of the intussusception.

The most extensive experiments on the mechanism of the invagination have been carried out by Nothnagel.[22] This author showed that if electric stimulation was applied to a segment of intestine a tetanic constriction followed, the portion of the bowel below the contracted area was pulled over the contracted portion like a sheath, and the growth of the intussusception took place by the pulling of more and more of the lower segment of bowel over the contracted portion. The experiments of D'Arcy Power[23] on the artificial production of intussusceptions essentially confirms the views of Nothnagel.[22] Nothnagel considered that the longitudinal muscles of the intestinal wall were chiefly active in pulling the normal intestine up over the spastic constricted portion. Fitzwilliams[3] and Treves[16] in general agree with this view; the latter describing the action of the longitudinal fibers as follows: "The action of the longitudinal fibres must extend beyond the line where the contracted and non-contracted parts of the intestine meet. If they be considered to act from the contracted segment as from a fixed point it is evident that they will tend to draw the wide non-contracted segment over the narrow and contracted piece. In this way, by the drawing of one part of the intestinal tube over another part, the intussusception is formed." Treves,[24] however, does not consider that this method of growth applies to the variety of intussusception where a portion of the ileum prolapses through the ileocecal valve. Here, according to this author, the invagination may increase for some time solely by the prolapse of more and more ileum, the sheath remaining unchanged. Later, when no more ileum can

enter, the cecum and ascending colon may be drawn into the sheath. Fitzwilliams[3] devotes considerable space in his article to the mechanism of the invagination.

Pathological Anatomy. Little that is fundamentally new in the pathology of intussusception has been added since Leichtenstern's classical monograph in 1873.[13] It is easily understood that the pathological picture presented by an intussusception depends largely on the extent of involvement of the mesenteric circulation. A simple invagination of the bowel that does not constrict the mesenteric vessels may result in very slight changes in the bowel wall, and the condition may be tolerated by the patient for weeks, or even months (one variety of the so-called "chronic intussusception"). In acute intussusception, however, constriction of the mesenteric vessels, particularly the veins, is the important factor. As already pointed out, the mesentery forms a wedge-shaped structure imprisoned between the entering and the returning layers (see Fig. 23); as the apex of the intussusception advances, more and more of the mesentery is drawn into the narrow neck and is progressively constricted. To this mechanical action is added the swelling and edema of the intestinal wall following the venous stasis and congestion, which further compresses the mesenteric vessels, particularly at the neck of the intussusception; the mesentery itself then becomes swollen and edematous and adds to the complications. The changes that take place in the bowel wall under these circumstances are similar to those that have been described under strangulation: they may vary from simple congestion and edema to complete infarction and gangrene. The intussusceptum, or swallowed portion, suffers first due to damage to its blood supply; and gangrene may be limited to the intussusception. In this respect, infarction of the bowel in intussusception differs from the infarction that follows strangulation by bands; for the gangrenous portion of the bowel may be entirely walled off from the general peritoneal cavity by the enveloping sheath, which at times furnishes complete protection against peritonitis or the

absorption of toxins.* In certain cases the intussusceptum, after undergoing degenerative processes, may be sloughed off at the neck of the invagination and be passed by rectum, constituting a spontaneous cure.† On the other hand, it may cause further trouble: cases have been reported where the necrotic portion of the bowel after being separated constituted a foreign-body obstruction lower in the intestinal canal; and Nothnagel says that the separated intussusceptum may set up a peristalsis so violent as to cause a rupture of the bowel at the point of recent attachment, with a resulting peritonitis.

The histological picture of the changes taking place in an intussusception is described in detail in the work of D'Arcy Power.[25] The layer of bowel forming the outer sheath (the intussuscipiens) may remain essentially normal; it may, on the other hand, due to the pressure and inflammation of the necrotic intussusceptum, be involved in the gangrenous process; or an intermediate condition may be found in which the wall is congested, thickened, and edematous. The mucosa may show ulcerations which may perforate, allowing the intussusceptum to protrude through the slough; the lumen of the bowel may be clogged or blocked by the swelling of the tissues or by clots of blood and débris. Angling or knuckling of the intussusceptum produced by the tension on the mesentery may also obliterate the lumen.

The different layers making up the intussusception may become so firmly adherent one to another as a result of inflammatory changes that reduction is impossible. Reduction may also be impossible simply from inflammation, congestion and edema, even in cases that come to the surgeon reasonably early.

Many interesting and curious details of the pathological changes found in association with intussusceptions are given in

* There are two types of obstruction in which infarction of the bowel may occur and absorption be at a minimum: one, in certain cases of intussusception; and the other in certain cases of strangulated external hernia.

† The ulcer left at the neck of the invagination after sloughing has taken place may, in the process of healing, lead to a stricture of the bowel. (Nothnagel).

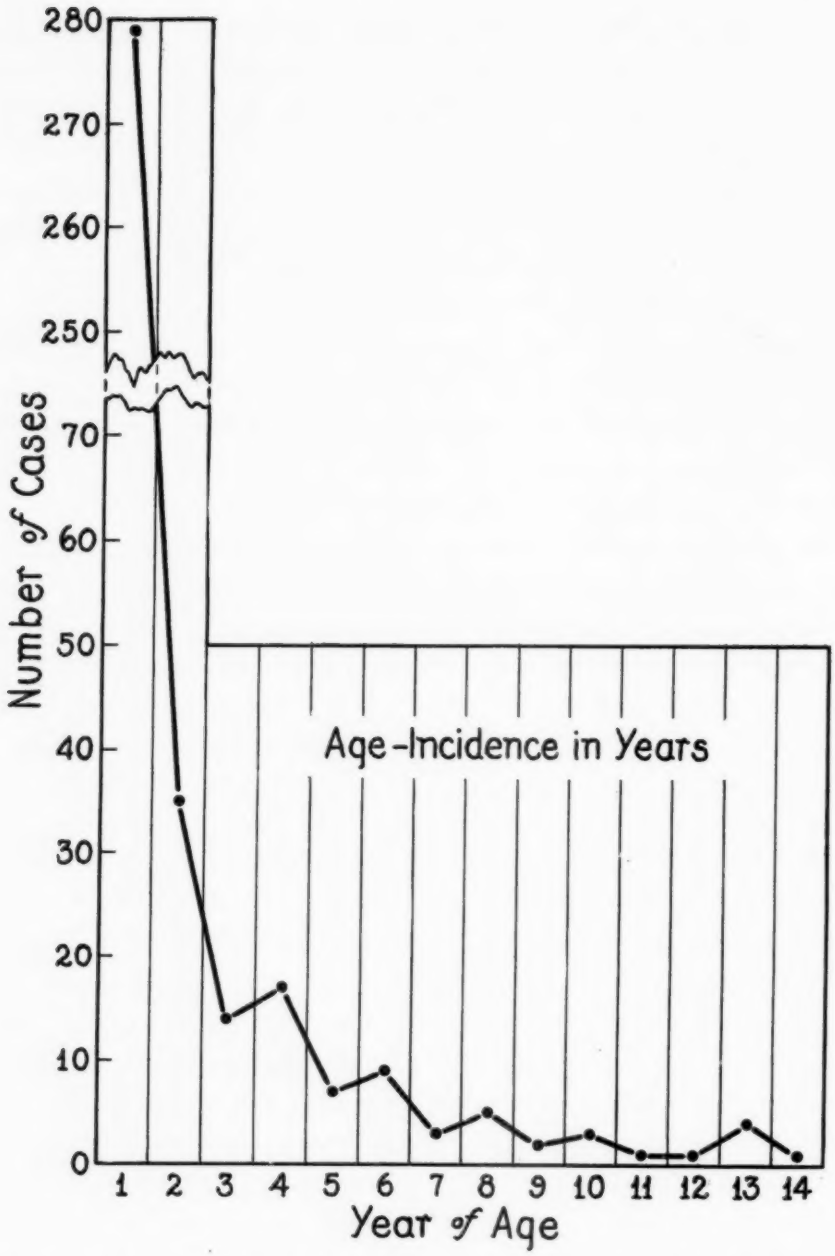

FIG. 27. Curve illustrating age incidence of acute intussusceptions, in years: 382 cases are included in the curve, which ceases at age of fourteen years, for convenience of insertion; 18 other cases occurred between ages of fourteen and fifty-eight, making the total 400. (From Perrin and Lindsay.[7])

the works of Treves[24] and Nothnagel.[22] Corner[12] points out that where a Meckel's diverticulum is patent an intussusception may protrude at the umbilicus.

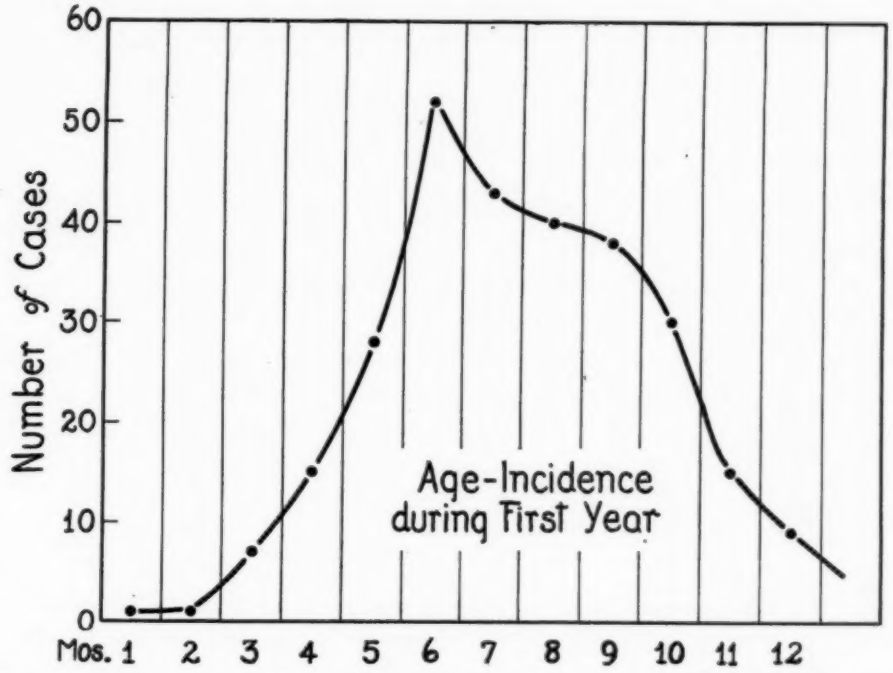

FIG. 28. Graph of age incidence of acute intussusception, in months during first year. (After Perrin and Lindsay.[7])

Clinical Features. Intussusceptions are divided clinically into acute and chronic types. The latter show no symptoms of acute intestinal obstruction and are not considered in this monograph; the reader is referred to articles by Jones[26] and Marsh[27] for a comprehensive description of the chronic type.

The acute cases fall into two major groups: those occurring in infants and young children; and those occurring in adults. According to Bolling,[28] about 75 per cent of all acute cases occur within the first year of life; Perrin and Lindsay[7] reported 78.5 per cent as occurring within the first two years (Fig. 27), the first year showing a very marked peak between the fifth and sixth months (Fig. 28).

Males are affected approximately twice as frequently as females, a rather striking fact that has never been adequately explained. The disease shows a definite seasonal variation

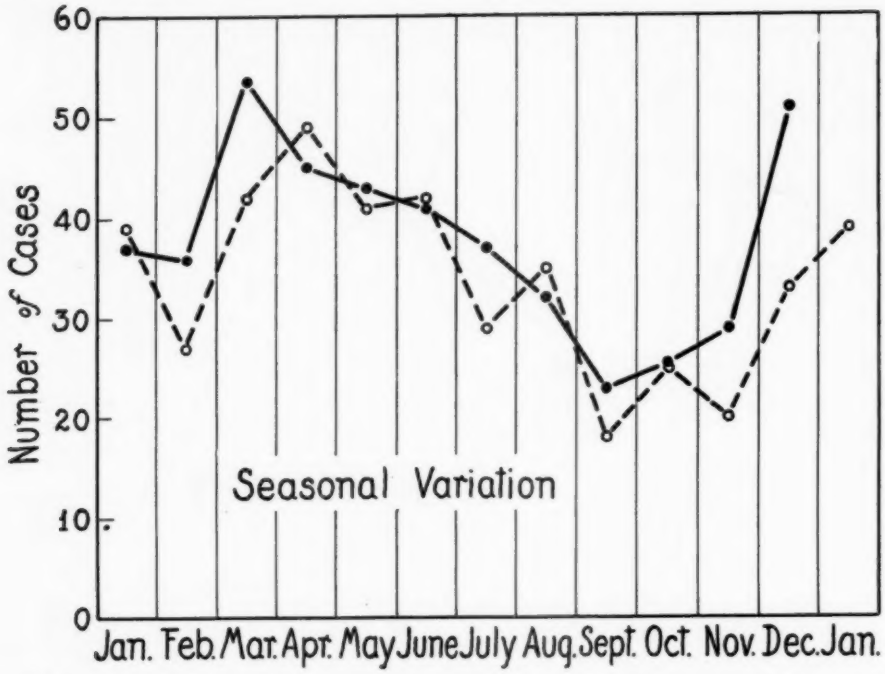

FIG. 29. Curves illustrating seasonal variation of acute intussusception, compiled from cases reported by Perrin and Lindsay[7] and by Fitzwilliams.[3] (Solid line, Fitzwilliams; broken line, Perrin and Lindsay.)

(Fig. 29), the greatest number of cases occurring in spring with a secondary peak in winter. The theories advanced to explain this seasonal variation are not convincing. It might be expected that the disease would reach its height during the summer season when the various types of infectious diarrhea are more prevalent; but it is evident that such is not the case, although Bolling[28] reports a small group where the intussusception occurred during an attack of "ileocolitis."

Indiscretions of diet are frequently mentioned as causing intussusception; but Close's studies[11] do not bear out this belief. Intussusception may occur as a complication of Henock's purpura. (See Diagnosis.*)

*This will occur in Part II of the book.

Intussusceptions may recur after operation. In Close's series of 363 cases, this occurred in 14 instances, usually within a month or two after operation, but in several instances after an interval as long as a year.

The clinical course in infants is usually typical. A previously healthy, well-nourished infant cries out while nursing or passing a stool; with the paroxysm of pain the knees are drawn up, and there may be a noticeable pallor. Vomiting is likely to take place soon after the onset of the attack. One normal stool may be passed; after that, only blood and mucus; occasionally some flatus may be passed. The paroxysm of pain may recur at frequent intervals. Even after the lapse of twenty-four hours, the infant may appear surprisingly normal and without signs of shock, so that from the general appearance it may be difficult to realize that the situation is so serious. In the later stages the infant may look extremely ill and show signs of collapse; the most serious cases where death follows operation are likely to show a marked elevation of temperature.[1]

On physical examination of the abdomen the characteristic "sausage-shaped" mass can usually be palpated. Distention is not likely to be marked in the early stages. On rectal examination the apex of the intussusception may be felt, or, rarely, it may be seen protruding from the anus.

In contrast to the uniformity of the picture in infants and children, the picture in the adult is usually not characteristic and the diagnosis is often made only at operation. The clinical signs and symptoms may point strongly to an acute obstruction; but the typical features of intussusception (passage of bloody mucus by rectum, and the characteristic abdominal mass) are often absent.[8] One reason for their absence is that these intussusceptions are frequently of the enteric variety. A more detailed discussion of intussusception in the adult will be found in articles by Eliot and Corscaden,[9] Watts,[10] and McIver.[8]

Cases IX and X are typical of intussusception in infants:

CASES IX and X. *Obstruction by intussusception.*

No. 7705, MIBH. Female, aged three months. The infant was full term, normally delivered, and had been well up to the onset of the present illness. There had been no digestive disturbances except slight constipation.

On the morning of admission the infant waked at 5 A.M., cried and drew up her legs as though in pain. A mild cathartic was given by the parents, and almost immediately a small amount of bloody mucus was passed by rectum. The infant was seen about six hours later. There were periods in which she cried as though in pain. There was some pallor of the mucous membranes; but the general condition appeared good. The abdomen was soft and not distended. In the region of the left upper quadrant and extending across toward the mid-line a rounded mass could be felt very definitely at one time, while examination a few minutes later showed that it had disappeared; after a short interval the child began to cry again, and again the mass could be felt. This probably coincided with a wave of violent peristalsis. Rectal examination was negative. The white blood count was 11,000; temperature 98°F. A barium enema showed the main column of barium stopping rather sharply in the region of the splenic flexure. The roentgenologist considered the picture very suggestive of an intussusception.

A diagnosis of intussusception was made, and an abdominal operation was carried out under ether anesthesia. At operation an intussusception was found, the apex lying in the transverse colon to the left of the midline. The intussusception was easily reduced by taxis. After the small intestine had been "milked out" of the colon, it was noticed that a second intussusception was present in the ileum about 12 cm. from the ileocecal valve. This intussusception was about 4 or 5 cm. in length and was reduced with slightly more difficulty because of the edema and swelling. The portion of the bowel involved in the intussusception was edematous and cyanotic in appearance, but appeared definitely viable; it was obvious that no resection was required. In the mesentery of the small intestine at the point of the intussusception there were several enlarged lymph glands about 1.5 cm. in diameter which may have been an etiological factor in the production of the intussusception. The infant had an uneventful convalescence.

Comment: This intussusception was of the compound ileocolic variety. The diagnosis was fairly obvious: there was the typical picture of a previously healthy infant suddenly crying out and drawing up the legs as though in pain, and shortly afterward passing bloody mucus by rectum. The fact that the mass could be felt at times and at other times could not is somewhat atypical. A few hours' delay in this case might have been very serious, since the circulation to the involved section of bowel was obviously seriously jeopardized. It was, of course, a mistake on the part of the

parents to give the infant a cathartic: unfortunately this is a common first procedure in cases with abdominal pain; in this case it undoubtedly aggravated the symptoms.

No. 5415, MIBH. Male, aged six months. The infant had been well previous to the time of the present admission. The mother states that on the morning of admission the baby appeared to have severe abdominal colic, crying out and drawing up his legs. Castor-oil was administered; this was promptly followed by vomiting and the baby began to pass bloody mucus from the rectum. An enema produced more of this bloody discharge; there was no bowel movement. A few hours later the mother noticed a mass in the left lower quadrant of the abdomen and brought the infant to the hospital.

Examination showed an extremely sick child: the mucous membranes were pale; the pulse rapid; the child was very apathetic and lay quietly on the examining-table, although at intervals he cried out as though in pain, drawing up his legs. A definite mass, somewhat "sausage-shaped" in outline, could be felt in the lower left quadrant and on rectal examination this could be palpated in the pelvis. The abdomen was not distended. There was no muscle spasm and no marked tenderness. The white blood count was 18,000, differential showed polymorphonuclears 82 per cent, small lymphocytes 17 per cent, large lymphocytes 1 per cent. Temperature was 99°F.

Diagnosis of intussusception was made, and immediate operation advised. The abdomen was opened under ether anesthesia. The apex of the intussusception was located in the sigmoid. It was reduced by taxis. The first part of the reduction was simple; but as the apex neared the cecum there was difficulty in effecting complete reduction; this, however was accomplished. Although edematous and somewhat discolored, the lower portion of the ileum was evidently viable. There was a mass of enlarged mesenteric glands in the ileocecal region, the largest being about 2 cm. in size, and a dense, fibrous band which passed across the ileocecal valve and appendix and terminated in the group of glands. This band was divided; the abdomen was closed and the child returned to the ward in fair condition. The infant showed a rather marked elevation of temperature for the first two days; after that time there was an uneventful convalescence.

Comment: The history and physical findings in this case (sudden onset of abdominal pain in a previously healthy infant, followed by the passage of bloody mucus, and after a few hours a palpable mass in the abdomen) were typical of intussusception. A strong cathartic was administered at the onset of the illness, which was unwise and only served to aggravate the symptoms.

CASE XI. *Obstruction from enteric intussusception due to Meckel's diverticulum.*

No. 284725, MGH; Male, aged twelve. History meager, and rather unreliable, since the boy was somewhat irrational and mother spoke no English. Patient is said to have had attacks of mild abdominal pain, lasting fifteen or twenty minutes, during past eight months; occasionally vomited during these attacks.

Forty hours before admission the patient was taken with severe, generalized, abdominal pain, which was attributed to green apples eaten the day before. Vomited a number of times during the first day; pain persisted. Was given castor oil, which was vomited. During the day of admission the pain was said to have been more severe in the right lower quadrant; vomited five or six times, the vomitus being greenish in color and without odor. Bowels had not moved for two days previous; no symptoms referable to cardiorespiratory or genitourinary system.

Physical examination showed a slightly built boy of twelve, apparently in considerable pain, excited and disturbed mentally. Abdomen was scaphoid in appearance, moving only slightly with respiration. Marked muscle spasm over the whole abdomen, most marked on the right side; also marked generalized tenderness, perhaps somewhat more pronounced on the right side; no masses could be felt. Rectal examination was unsatisfactory because of lack of cooperation; definite tenderness, however, could be elicited. Temperature 104°F.; white blood count 27,000.

It appeared obvious from the physical examination that we were dealing with some acute pathological condition in the abdomen requiring surgical treatment. It was thought most likely that this was a fulminating appendicitis, although intestinal obstruction was considered.

Operation was undertaken under ether anesthesia, the abdomen being opened through a right rectus muscle-splitting incision. When the peritoneum was opened, free fluid, slightly dark in color, escaped. On exploring with the hand, a mass was felt in the pelvis which on delivery proved to be an intussusception about 20 cm. from the ileocecal valve. A few centimeters of the intussusception were reduced and the bowel found to be gangrenous. It was impossible to reduce the intussusception further, so the whole affected portion was resected. No anastomosis was attempted at this time, since the patient was in very poor condition: he took the ether badly; his pulse soon rose to 150; he became very cyanotic, and respiration stopped. Under artificial respiration breathing again started and no more ether was given. Clamps were left on the distal and proximal ends of the bowel and these were brought out through the wound, which was rapidly closed around it. At the end of the operation the patient was given glucose intravenously and was returned to the ward in fair condition.

The pulse and temperature remained elevated for several days after operation, gradually returning to normal. Clamps were removed from the bowel the second day postoperative, and drainage was free. There was some breaking down of the wound and digestion by the intestinal secretions; but the boy's general condition was good after he had recovered from the acute phase.

About three weeks after the first operation, the wound was opened, a few inches of the ends of the intestine were resected and an end-to-end anastomosis was carried out. The appendix, which was adherent in the region of the wound, was removed.

The boy was discharged twenty-one days after the second operation in good condition. He was seen again three weeks later in good health and symptom-free.

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THIS MONTH'S CONTRIBUTORS

AMADON, PHILIP D., M.D., Monroe, Mich.
Attend. Surg., Mercy Hosp.

ANGLE, LEWIS W., M.D., Kansas City, Kan.

BANDLER, CLARENCE G., M.D., F.A.C.S., N. Y.
Prof. Urol., N. Y. Post-Grad. Med. Sch. & Hosp.; Attend. Urol., N. Y. Post-Grad. Hosp.; Cons. Surg., Home for Aged & Infirm (Yonkers); Cons. Urol., King's Pk. State Hosp.

BEHAN, R. J., Dr. Med., M.D., F.A.C.S., Pittsburgh, Pa.
Surg., St. Joseph's, City & Pittsburgh Tub. Hosp.; Author: "Pain," N. Y., 1920.

BETTMAN, RALPH B., M.D., F.A.C.S., Chicago.
Assoc. Prof. Clin. Surg., Rush Med. Sch., Univ. Chicago; Attend. Surg., Cook Co. Hosp.; Assoc. Attend. Surg., Michael Reese Hosp.

BISGARD, J. DEWEY, M.D., Ann Arbor, Mich.
Instr. Surg., Univ. Mich.

CHARNOCK, DONALD R., M.D., Los Angeles, Calif.
Staff Mem., Hollywood & Cedars of Lebanon Hosp.

D'ACIERNO, PELLEGRINO A., M.D., Union City, N. J.
Attend. Obst. & Gynec., No. Hudson Hosp. (Weehawken); Asst. Attend. Obst., Margaret Hague Maternity Hosp. (J. C.)

DENTON, JAMES, M.D., Bklyn.
Pathologist, Brooklyn Hosp.

EDMUNDS, L. H., M.D., Seattle, Wash.
Assoc. in Orthop., Mason Clin.; Mem. Staff, Virginia Mason Hosp.

EISING, EUGENE H., M.D., F.A.C.S., N. Y.
Attend. Surg., Hosp. for Joint Dis. & Sydenham Hosp.

FLAGG, PALUEL J., M.D., N. Y.
Vis. Anes., Manhattan Eye & Ear Hosp.; Anes., St. Vincent's, 5th Ave. & Flower Hosp.; Cons. Anes., Jamaica, Mt. Vernon, St. Joseph's (Yonkers), Mary Immaculate, Flushing, St. Mary's (Far Rockaway), & Misericordia Hosp.; Author: "Anesthesia," Ed. 5, Phila., 1932.

GOLDFEDER, ANNA, Dr. Sc., N. Y.
Fellow in Cancer Res., Lenox Hill Hosp.

GOODMAN, HENRY I., M.D., N. Y.
Dir., Dept. Thoracic Surg., Broad St. Hosp.; Thoracic Surg., Nassau Co. Tub. San. (Farmingdale), Columbia Co. San. (Philmont), & O'dell Mem. San. (Newburgh); Assoc. Surg., N. Y. Post-Grad. Hosp.

GRANET, EMIL, M.D., N. Y.
Assoc. Vis. Phys., Metropol. Hosp.; Adj. Gastroent., Beth Israel Hosp.; Sr. Clin. Assist. Gastroent., Mt. Sinai Hosp.; Asst. Roentgen., Gouverneur Hosp.

KAUFMAN, LOUIS R., M.D., F.A.C.S., N. Y.
Chief, Urol. Clin., Flower Hosp.; Attend. Surg., Park East Hosp.; Cons. Surg., Mt. Vernon Hosp.; Cons. Urol., Wm. McKinley Hosp. (Trenton), Hackensack Hosp.

KELLOGG, EDWARD L., M.D., F.A.C.S., N. Y.
Prof. Surg., N. Y. Polyclinic Med. Sch.; Dir. Surg. Gouverneur Hosp.; Attend. Surg., Polyclinic & Broad St. Hosp.

KELLOGG, WILLIAM A., M.D., F.A.C.S., N. Y.
Clin. Prof. Surg., N. Y. Polyclinic Med. Sch.; Attend. Surg., Polyclinic & Broad St. Hosp.; Assoc. Surg., Gouverneur Hosp.

KEYES, EDWARD L., M.D., F.A.C.S., N. Y.
Prof. Urol., Cornell Univ. Med. Coll.; Urol. N. Y. & St. Vincent's Hosp.; Cons., Memorial & Bellevue Hosp.

KRAMER, SAMUEL E., M.D., N. Y.

LILE, MINOR C., M.D., F.A.C.S., Seattle, Wash.
Chief, Orthop. Dept., Mason Clin.; Mem. Staff, Virginia Mason Hosp.

LUCK, J. VERNON, M.D., Los Angeles, Calif.
Res. Phys., Los Angeles Co. Hosp.

MCCARTHY, JOSEPH F., M.D., F.A.C.S., N. Y.
Prof. Urol., Col. Univ.; Dir., Dept. Urol., N. Y. Post-Grad. Med. Sch. & Hosp.

MCMULLIN, J. J. A., M.D., F.A.C.S., Comm., M. C., U. S. N. Phila.
Chief, Surg. Staff., U. S. Naval Hosp.

MEREDITH, JOHN M., M.D., Boston, Mass.
Fellow in Surg., Lahey Clin.

POTTER, EUGENE B., M.D., F.A.C.S., Ann Arbor, Mich.
Asst. Prof. Surg., Univ. Mich. Med. Sch.

SMITH, R. NICHOL, M.D., Los Angeles Calif.

STEVENS, A. R., M.D., F.A.C.S., N. Y.
Assoc. Prof. Urol., Cornell Univ. Med. Sch.; Attend. Surg., Dir. Urol., Bellevue Hosp.

STOUT, GURN, M.D., Los Angeles.
Staff Member, Hollywood Hosp.

THOMPSON, MALCOM, M.D., Louisville, Ky.
Mem. Surg. Staff, St. Joseph's Inf. & Cancer Clin.

WELLMAN, J., M.D., Ann Arbor, Mich.

WETHERELL, FREDERICK S., M.D., F.A.C.S., Syracuse, N. Y.
Asst. Prof. Surg., Syracuse Univ. Med. Coll.; Attend. Surg., Syracuse Mem. Hosp.; Attend. Gynec., St. Joseph's Hosp.; Cons. Surg., St. Lawrence State Hosp.

WOLEPOR, BEN, M.D., Montreal, Canada.
Outdoor Dept., Gen. Med., Royal Victoria Hosp.